U.S. DEPARTMENT OF COMMERCE
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PB-261 514

Evaluation of the National Pesticide Monitoring Program (NPMP)

Battelle Columbus Labs, Ohio

Prepared for

Environmental Protection Agency, Washington, D C Office of Pesticide Programs

Mar 75

PB 261 514

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TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. --------	2. ---------	3. RECIPIENT'S ACCESSION NO. ---------
4. TITLE AND SUBTITLE Evaluation of the National Pesticide Monitoring Program (NPMP)		5. REPORT DATE March, 1975 6. PERFORMING ORGANIZATION CODE ---------
7. AUTHOR(S) T. E. Carroll, W. T. Lawhon, D. A. Holzworth, and R. S. Reimers		8. PERFORMING ORGANIZATION REPORT NO. ---------
9. PERFORMING ORGANIZATION NAME AND ADDRESS Battelle Memorial Institute Columbus Laboratories 505 King Avenue Columbus, Ohio 43201		10. PROGRAM ELEMENT NO. --------- 11. CONTRACT/GRANT NO. 68-01-2296
12. SPONSORING AGENCY NAME AND ADDRESS Office of Pesticide Programs U. S. Environmental Protection Agency Washington, D. C. 20560		13. TYPE OF REPORT AND PERIOD COVERED Final 14. SPONSORING AGENCY CODE ---------
15. SUPPLEMENTARY NOTES		

16. ABSTRACT

The objectives of this program were to evaluate the effectiveness of the National Pesticide Monitoring Program (NPMP), identify program strengths and weaknesses, and recommend actions necessary to increase program capability. Specific tasks accomplished included: (1) Compilation of NPMP Data - Available data were grouped by relevant parameters such as environmental component monitored, frequency of collection, number and location of samples taken, chemicals monitored and means of monitoring; (2) Effectiveness of NPMP System - The available data were assessed with respect to drawing statistical inferences on trends in national pesticide residue levels, and data limitation problems identified; (3) Survey State Monitoring Activities - The emphasis of this task was on the determination of data availability to augment a national system; and (4) Recommendations - This task considered implications of project findings with respect to policy options available to Government for improving pesticide monitoring capability.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Pesticides National Pesticide Monitoring Program Systems Analysis	------	-----

18. DISTRIBUTION STATEMENT -------	19. SECURITY CLASS *(This Report)* ------	21. NO. OF PAGES -----
	20. SECURITY CLASS *(This page)* ------	22. PRICE -----

EPA Form 2220-1 (9-73)

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Evaluation of the National Pesticide Monitoring Program (NPMP) -- Final Report		5. REPORT DATE March 1975
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) T.E. Carroll; W.T. Lawhon; D.A. Holzworth; R.S. Reimers		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Battelle Columbus Laboratories Columbus Ohio		10. PROGRAM ELEMENT NO.
		11. CONTRACT/~~GRANT~~ NO. EPA-68-01-2296
12. SPONSORING AGENCY NAME AND ADDRESS Office of Pesticie Programs U.S. Environmental Protection Agency Washington DC		13. TYPE OF REPORT AND PERIOD COVERED
		14. SPONSORING AGENCY CODE

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This report seeks to accomplish the following tasks: 1) To compile available NPMP data by relevant paramters such as environmental component monitored, frequency of collection, number and location of samples taken, and chemicals monitored; 2) to assess thedata with respect to drawing statistical inferences on trends in national pesticide residue levels and data limitation problems. 3) to report on the availability of data from state monitoring activities to augment the NPMP; and 4) to consider implications of the study findings with respect to policy options available to the EPA for improving pesticide monitoring capability.

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a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES 160
	20. SECURITY CLASS *(This page)*	22. PRICE $6.75

EPA Form 2220-1 (9-73)

FINAL REPORT

on

EVALUATION OF THE NATIONAL PESTICIDE MONITORING PROGRAM (NPMP)

by

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MARCH, 1975

Contract No. 68-01-2296

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Washington, D.C. 20460

Prepared for

OFFICE OF PESTICIDE PROGRAMS
U. S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D. C. 20460

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CHAPTER 1. SUMMARY AND FINDINGS

INTRODUCTION

In 1964, the President's Science Advisory Committee recommended the development of a continuing network to monitor pesticide residue levels in air, water, soil, man, wildlife, and fish. Partially in response to this recommendation, a National Pesticide Monitoring Program (NPMP) comprised of monitoring activities conducted by various Federal agencies evolved. At the present time, the NPMP activities are coordinated through the Monitoring Panel of the Federal Working Group on Pest Management.

With the passage of the Federal Environmental Pesticide Control Act of 1972, the Environmental Protection Agency (EPA) became the focal point of Federal policies and activities relative to pesticide residue levels in the environment. The Act also requires the Administrator of EPA to develop and implement a national strategy with respect to pesticides in the environment, including the preparation of a National Pesticide Monitoring Plan. This plan will utilize wherever possible existing pesticide monitoring networks, such as the NPMP.

The NPMP has been in various stages of development and operation, since 1964. During this period, fragmentation of objectives and priorities of the data collecting agencies, curtailment of monitoring activities due to resource constraints, and variations in basic monitoring parameters have occurred. These aspects all suggested the need for an assessment of the NPMP. This report presents the results of this assessment.

OBJECTIVES

The specific objectives of this effort are, therefore, to evaluate the effectiveness of the NPMP, identify program strengths and weaknesses, and recommend actions necessary to increase the program capability. This study seeks to accomplish the following tasks in sequence:

(1) To compile available NPMP data by relevant parameters such as environmental component monitored, frequency of collection, number and location of samples taken, and chemicals monitored.

(2) To assess the data with respect to drawing statistical inferences on trends in national pesticide residue levels and data limitation problems.

(3) To report on the availability of data from state monitoring activities to augment the NPMP.

(4) To consider implications of the study findings with respect to policy options available to the EPA for improving pesticide monitoring capability.

Each of these aspects is considered separately in the subsequent chapters of this report.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Chapters 3 and 4 present the details of the data compilation and data assessment tasks, respectively. Based upon the results of these tasks, the following conclusions have been drawn.

(1) Overall NPMP management control does not exist. The NPMP is essentially an association of subprogram directors, who are responsible to different agencies.

(2) As there is no direct NPMP management, subprogram accountability and operational continuity with respect to the objectives of the NPMP have suffered. BCL considers these two factors to be the major findings of this research. Accountability is made impossible by the parallel but separate management systems of

the subprograms. Subprogram continuity is apparently subject to the philosophy and funding of the particular agency in which the subprogram resides.

(3) Sampling and analytical methodologies within each subprogram have improved with time. Experimental designs have also been improved in terms of their potential to provide statistically reliable data. However, while such changes tend to improve future system capabilities, their immediate effect can be to limit the amenability of the current data base for determining long-term trends. Thus, it is important to carefully plan and implement the change so as to not disrupt the continuity and integrity of the developing data base.

(4) In most cases the compilation, evaluation, and publication of the collected data lags considerably behind the field collection and sample analysis period. Lags of 3 to 4 years have been noted. Collected experimental units have been known to lie in frozen storage for over a year before being chemically analyzed. Such a practice is not consistent with the NPMP objective of identifying short-term problem areas.

(5) Battelle has been unable to define the rationale used by the subprograms to determine what pesticides are to be monitored.

(6) There is considerable confusion as to exactly what pesticides are actually being monitored. Battelle has found wide variations, in the literature, concerning this point. In some cases, only those chemicals found in significant amounts are reported, with no statement made concerning other pesticides monitored but not detected.

(7) The effectiveness of the National Pesticide Monitoring Program in identifying critical short-term pesticidal problem areas and in determining long-term trends in residue levels is contingent on the quality and effectiveness of each subprogram. It is recognized that each of the subprograms has developed experimental designs for collecting data specific to the subprogram objectives, which are influenced by agency priorities. As a result, conflicts between stated NPMP objectives and subprogram objectives are present. This directly affects the resultant data.

(8) While of interest, the data collected by the Eagle Monitoring Program cannot satisfy basic statistical assumptions necessary to identify problem areas and to detect long-term trends. The Meat and Poultry Inspection Program is specifically designed to control the quality of meat products reaching the public market. As with the Eagle program these data do not satisfy basic statistical needs of the NPMP.

(9) Another problem recognized by BCL is that some subprograms have been known to correctly identify problem areas and then prompbly embark on "special studies" for an in-depth assessment of the problem. To the extent that special studies divert NPMP funds and resources supporting collection of baseline and trend data, this is clearly detrimental to NPMP objectives. A national monitoring program striving for statistically relevant data must have consistent and comprehensive nationwide sampling. The assessment of localized pesticide problems is of critical importance to public health and should logically be initiated on the basis of NPMP findings; however, use of the limited NPMP resources for these efforts restricts the overall effectiveness of an NPMP.

(10) The data suggest that states are planning and executing monitoring programs on the basis of their own particular needs. These programs are also influenced by many of the same constraints which affect monitoring programs at the national level (i.e., budget, manpower, changing priorities, etc.). Therefore, BCL rejects the utilization of state monitoring data as a realistic policy option for improving NPMP capabilities.

(11) No attempt has been made to correlate pesticide monitoring and use data. This is principally due to the fact that adequate pesticide use data are not available.

(12) Before inter-component relationships could be statistically investigated, standardization of analytical techniques must occur. Under current conditions, the validity of any attempted correlation of analytical results would be questionable, due to the variations in current analytical techniques as discussed in Chapter 3.

(13) There have been no attempts to correlate the spatial and temporal relationships between environmental components. In fact, a mechanism for such an effort does not exist. The Federal Working Group on Pest Management serves in an advisory capacity and could only recommend such an effort. Under the present structure, funding would have to be specially appropriated and responsibility and coordination delegated to a participating agency in such a manner as to not interfere with the routine activities of the NPMP.

(14) EPA is concerned with using NPMP data as a basis for identifying critical short-term problem areas and in determining long-term trends in residue levels. Thus, the primary emphasis must be on providing statistically reliable data based on an a priori NPMP experimental design. No such design is in evidence.

RECOMMENDATIONS

(1) EPA should develop an overall National Pesticide Monitoring Program Experimental Design which integrates both pesticide monitoring and pesticide research activities.

(2) One office, within the hierarchy of EPA, should be charged with the responsibility of designing, coordinating and maintaining pesticide activities for the Federal Government. Such an arrangement would insure that pesticide monitoring and pesticide research would be properly integrated so that monitoring activities address necessary and realistic goals. This concept is developed in the discussions pertaining to Policy Option 3 in Chapter 6.

(3) EPA should develop a rationale for determining what pesticides should be monitored.

(4) EPA should conduct and fund research projects which will:

- address pesticide transfer rates and amounts between trophic levels of given ecosystems
- determine pesticide sinks within the environmental components currently being sampled by NPMP activities
- address the effects of pesticides on public health, and ecosystem productivity
- develop pesticide transport and pesticide effects models.

(5) Special studies, based on NPMP findings, should not be initiated if it involves the diversion of NPMP resources or in any way restricts the fulfillment of the NPMP experimental design.

(6) Before state pesticide monitoring data are utilized or incorporated into the NPMP, an in-depth study should be made to assess the quality of those data. BCL's analysis of the state data, which were provided by the

Smithsonian Center for short-lived Phenomena, indicate that the quality of state data is questionable with respect to drawing statistical inferences. The reasons are: different sampling techniques; different sampling frequency and environmental components monitored; different analytical techniques, and lack of a formal data reporting mechanism.

(7) BCL suggests that the Eagle Monitoring Program and the Meat and Poultry Inspection Program be re-assessed as functional elements of the NPMP.

(8) In order to enhance the comparability of data within and between NPMP subprograms, BCL suggests the development of a manual or set of guidelines with respect to analytical methodologies utilized by the NPMP. Such a manual would specify sample treatment phases for each media analyzed, and would present a common technique for pretreatment and final analysis.

(9) At least two laboratories should be utilized by the subprograms to conduct the analysis and/or cross-checking of samples collected by the subprograms.

(10) It is recommended that radioisotope tracers be used to conduct routine bioaccumulation and analytical recovery studies. In this manner, the absolute treatment and recovery efficiencies for the various techniques used by the NPMP could be determined.

CHAPTER 2. BACKGROUND

INTRODUCTION

The complex environment inhabited by man includes many species of plants and animals which are necessary to his well-being and many species that are debilitating or potentially harmful to him. Both groups impinge upon most all of man's activities and, consequently, have been the subjects of constant attempts by man to adjust, alter, or control in his favor. In the past few decades, man has greately increased his capability to control and, in some cases, eradicate members of the latter group (i.e. - a diverse assemblage of unwanted, often destructive plants and animals). This has been made possible largely through the development and widespread use of a host of chemical compounds commonly referred to as pesticides. By 1976, over 40,000 such products will have been registered and classified by the Environmental Protection Agency (EPA 1974).

The widespread use of large amounts of these chemical compounds is shown in a recent report on the agricultural use of pesticides (Andrilenas 1974). This report indicates that about 833 million pounds of pesticides (not including sulfur or petroleum) were used in the United States in 1971. Of this amount, farm use to control fungi, weeds, insects, mites, nematodes, and rodents accounted for about 494 million pounds, an increase of 40 percent over the 1966 useage. The remaining 339 million pounds were used by government, industry, institutions, and homeowners.

Within the past decade, much concern has been expressed over the use of such large amounts of toxic and often persistent chemicals in agriculture, disease - vector control, and in eliminating nuisance plants and animals. For such uses, these chemical compounds have been quite successful. The practice is, however, a two-edged sword in that the benefits to be realized are not obtained without incurring some degree of environmental risk or undesirable side effects. The EPA pesticides strategy (EPA 1974) succinctly addresses this aspect,

> "Pesticides, unlike most air and water pollutants, are intentionally released into the environment -- where their acknowledged benefits are expected to take place. In fact, largely because of those benefits, pesticides now have become increasingly important to agricultural production, to public health and sanitation, to protection of capital investments and natural resources, and to improvement of human comfort and well-being.
>
> However, since pesticides are biological poisons that are seldom specific as to the time, place, or target of their chemical activity, their proliferation in the environment has caused serious health and environmental problems and may be causing others not now well understood."

While much of the current research on pest control measures is being directed toward nonchemical means (e.g., biological control, breeding resistant plants, sterilization, genetic manipulation), the use of chemicals will continue to play a predominant role in pest control practices for some time to come. It is, therefore, necessary to study and evaluate the present levels of such chemicals in the environment, the trends in these levels, and the long-term effects of the chemicals and/or their break-down products on various components of the environment.

In order to conduct such an evaluation, it is necessary to have adequate amounts of reliable and accurate data relative to the distribution of the various chemical compounds in the environment and the changes in their levels over time. Such data cannot be obtained or extracted wholly from research studies or field trials. Consequently, ambient monitoring of selected environmental components is necessary.

Recognizing this need, the President's Science Advisory Committee recommended, in 1964, the development of a national monitoring program to determine the pesticide residue levels in the environment. In response to this recommendation, the National Pesticide Monitoring Program (NPMP) was established as a cooperative effort of several government agencies from the USDA, DHEW, and USDI. The major objectives of the NPMP were to:

(1) determine the ambient levels of pesticides, their residues and other major pollutants in selected environmental components: soil, air, water, estuaries, raw agricultural crops, food and feed, fish, wildlife and humans

(2) determine the changes in these levels over time.

This cooperative, interagency arrangement continued until the establishment of the Environmental Protection Agency (EPA) in December, 1970. At that time, the monitoring activities relative to soil and agricultural crops, air, estuaries, water, and humans were transferred to the EPA (Wiersma, 1974). With the passage of the Federal Environmental Pesticide Control Act of 1972 (Public Law 92-516) the program received legislative status and the EPA became the focal point of Federal policies and activities relative to pesticide residue levels in the environment.

As such, the EPA now bears the major responsibility within the Federal Government for the development and implementation of an effective national strategy relative to pesticide residues in food-stuffs, air, water, soil, man, and wildlife. Encompassed in this charge is (a) the ability to identify relevant data existing within the numerous pesticide monitoring activities and the capacity to obtain access to these data, (b) the analyses and evaluations of data obtained from the monitoring activities to present a comprehensive picture of the status of pesticide residues in the environment to decision-makers, and (c) the communication of these assessments to appropriate action groups within and outside the EPA.

The Problem

The development of this strategy will require a statistically sound foundation of accessible and useful data on the current status of pesticide residue levels in environmental components, on changes and trends in these levels, and what the changes mean. Even a cursory review of the past and present NPMP activities reveals that a vast amount of data has been and is being collected by the various elements of the NPMP. It is also obvious that numerous independent changes have occurred in these elements since the NPMP was implemented in 1964. Unfortunately, the lack of adequately detailed consideration and documentation of these changes apparently has reduced the commonality of NPMP data with respect to other data collected at the same time or place. As a result, it is not now certain if sufficient amounts of proper data are available to accurately and reliably assess, on either a single- or multi-media basis, the current status and trends of pesticide residue levels in the environment. In attempting to utilize these data, several questions arise ranging from the source and/or availability of the data to the relationships between the environmental variables measured in the past and current relevant parameters.

Against this background, the EPA, as mentioned earlier, is now the focal point for development and implementation of Federal policies and activities relative to pesticide residue levels in the environment. The efficient and effective fulfillment of this responsibility is contingent among other things upon a clear understanding of the effectiveness of the data collection and analysis mechanism (the NPMP) which has been in various stages of development and change since 1964. The fragmentation of objectives, the priorities of various data collecting agencies, the curtailment of monitoring activities due to resource constraints, and variations in basic monitoring parameters which have occurred during this period have mandated a need for an assessment of the NPMP with respect to its ability to fulfull its stated objectives.

CHAPTER 3. COMPILATION OF NPMP DATA

INTRODUCTION

The NPMP represents an extensive interagency activity currently maintained by the Environmental Protection Agency (EPA), the Food and Drug Administration (FDA), the United States Geological Survey (USGS), the Bureau of Sport Fisheries and Wildlife (BSFW), and the United States Department of Agriculture (USDA) to monitor pesticide residue levels in the environment. As initially conceived, the NPMP was "designed on the basis of the minimum monitoring needed to establish baseline levels of pesticides in substrates of food and feed, humans, soil, water, air, wildlife, fish, and estuaries and to assess changes in these levels" (Duggan 1971).

The NPMP has been in various stages of development since 1964, and has undergone numerous changes--changes to incorporate research investigations, utilize improved methodology, reflect changes in program emphasis, and to accommodate findings within existing programs (Duggan 1971). A comparison of Figures 1 and 2 indicates some of the changes which have taken place in the NPMP from 1967 to the present. These are rather obvious changes reflecting essentially an expansion of the scope and coverage of NPMP monitoring activities. Concurrently with such changes, however, other more subtle changes (e.g., experimental design changes, design fulfillment capability) have occurred in the various functional elements which comprise the NPMP. While somewhat less obvious, changes of this nature have wide-ranging implications with respect to meeting the stated NPMP objectives.

The expressed purpose of this research program is an assessment of the effectiveness of the NPMP which, in turn, is contingent upon the effectiveness of the various functional elements including the quality and quantity of data collected. Therefore, the purpose of this chapter of the report is to compile, for subsequent analysis, the data presently available from the NPMP.

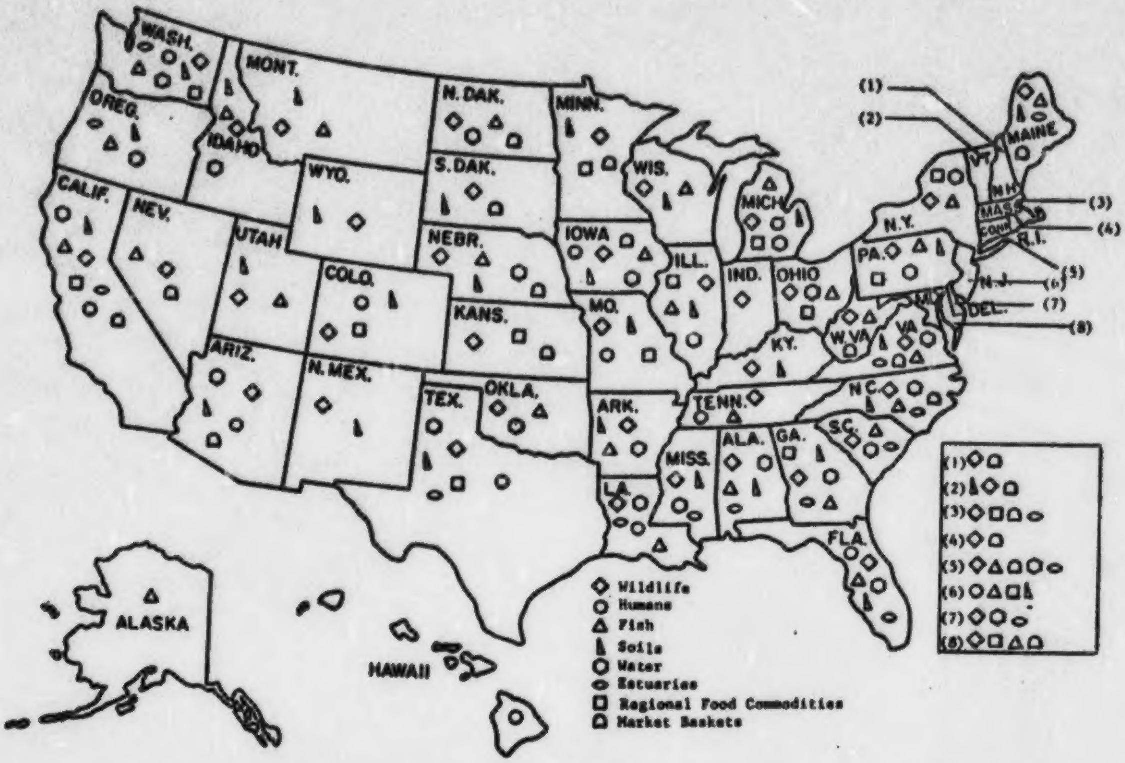
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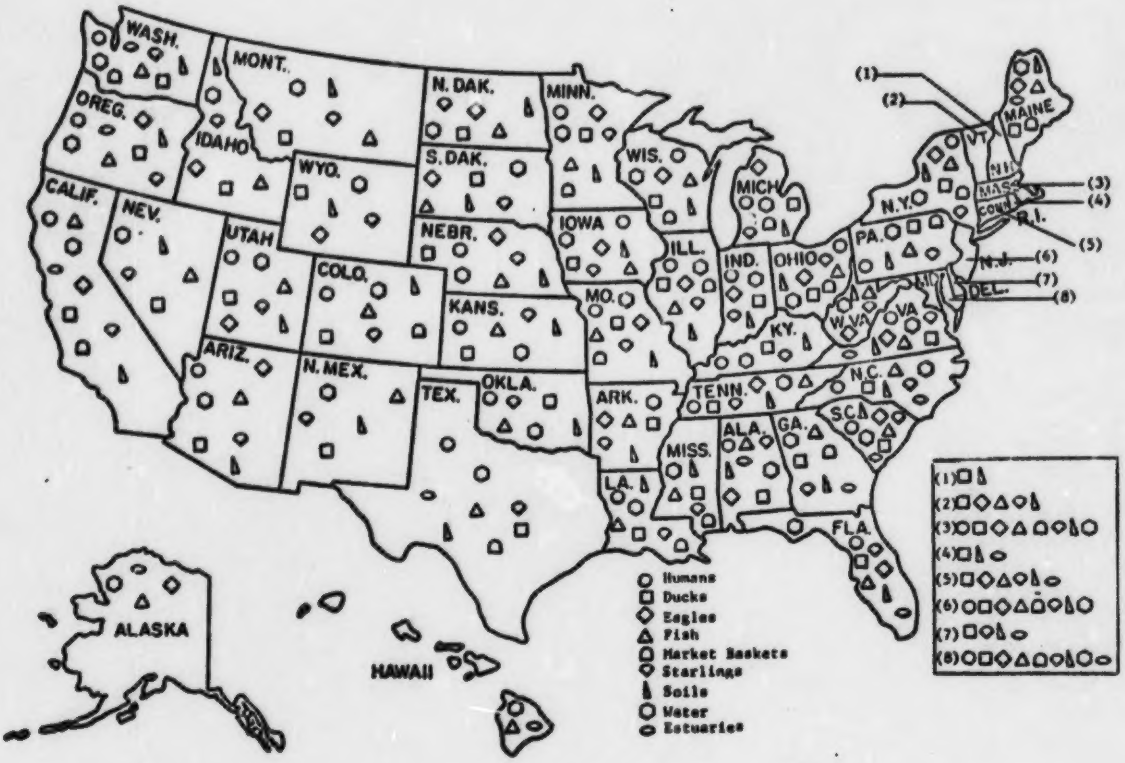
FIGURE 1. NATIONAL PESTICIDE MONITORING PROGRAM AS DEFINED IN 1967.
Source: Pesticide Monitoring Journal (1967)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Estuaries

FIGURE 2. NATIONAL PESTICIDE MONITORING PROGRAM AS DEFINED IN 1974.

As presently defined, the NPMP consists of the following eleven functional elements:

- Monitoring Residues in Food and Feed
    Market Basket Program
    Surveillance Program
    Meat and Poultry Inspection Program
- Monitoring Residues in Humans
- Monitoring Residues in Soils
- Monitoring Residues in Water
- Monitoring Residues in Wildlife
    Bald and Golden Eagles
    Estuarine Finfish and Shellfish
    Fish from Lakes and Rivers
    Mallard and Black Ducks
    Starlings.

Yobs (1971) recommended a national pesticide monitoring program for air. However, at the present time, there is no operational program for monitoring pesticides in air. Two pilot studies (1967-1968 and 1970-1971) have been conducted, and three designs are currently being studied for EPA at the Agricultural Research Center, Beltsville, Maryland. The development of sampling equipment, selection of analytical techniques, and lack of funding have prevented the program from getting underway (Spencer 1974). Available data for each of the above functional elements are compiled in the following discussions with respect to:

- Environmental Category Monitored
- Frequency of Collection
- Number and Location of Samples Taken
- Chemicals Monitored
- Means of Monitoring.

Analytical techniques employed by the various functional elements are discussed separately from the data compilation efforts.

COMPILATION OF NPMP DATA BY FUNCTIONAL ELEMENT

Monitoring Residues in Food and Feed

The objective of this element of the NPMP is to determine the levels of pesticide residues in unprocessed and commercially processed consumer food commodities, animal feeds, and composites of food items prepared for human consumption (Duggan and Cook 1971). To accomplish this objective three programs, as described below, are currently being conducted by the Food and Drug Administration (FDA) and the Department of Agriculture (USDA).

Market Basket Program

This program has been continuously operated by the FDA since 1964. Currently, a total of 30 market baskets are purchased nationwide from retail groceries in cities representing a standard metropolitan statistical area and those representing populations under 50,000 (Corneliussen personal communication). Each market basket consists of 117 items of food and beverages representative of the following 12 commodity groups: dairy products; meat, fish, and poultry; grains and cereal products; potatoes; leafy vegetables; legume vegetables; root vegetables; garden fruits; oils, fats, and shortening; sugar and adjuncts; and beverages (Duggan and Cook 1971).

The food items are now sent to FDA's Kansas City field office where they are cooked or otherwise prepared for consumption and then chemically analyzed for pesticide residues (Spencer 1974).

Information from the Market Basket Program is regularly interpreted on the basis of "dietary intake". As described by Spencer (1974), this is but another way of presenting the data on pesticide residues in the ready-to-eat foods. The interpretation of dietary intake from consuming a balanced diet of these foods is made biennially. It serves as a final check to determine that the tolerance and control systems which govern the use of pesticides in the United States are effective in assuring safe foods.

Data relative to this program are compiled in Table 1 by food class, chemicals monitored, and the number of positive composites by region for the period FY 1965 to FY 1972.

Through a review of unpublished data (Corneliussen 1974) it appears that, in FY 1973, the sampling scheme was expanded to include all ten FDA regions. Residue levels are currently reported by Consumer Specialists Offices within 18 of the 19 FDA Districts as shown in Table 2. The chemicals monitored as of FY 1973 are shown in Table 3.

Surveillance Program

This FDA operated program is designed to determine pesticide residue levels in individual commodities on a geographical basis and requires the sampling of individual food items or crops at their point of origin. Samples of unprocessed foods (including animal food ready for consumption) are collected at major growing, processing, and marketing centers by the Consumer Specialist Office in each of 18 FDA field districts. Sample analyses are also performed by FDA personnel within the respective field districts. Results from the field districts are then analyzed by FDA headquarters program analysis units to develop the national picture (Duggan and Cook 1971).

The monitoring efforts during the period 1955 to 1964 were mainly subjective; i.e., directed toward specific problem areas or pesticide use practices on a given crop. Currently, more emphasis is being given to objective sampling; i.e., samples are collected where there is no suspicion of excessive residues or misuse of pesticides (Spencer 1974).

For the purposes of this report, the compilation of data from the surveillance program during the period FY 1964-1969 is grouped into 17 food classes as shown in Table 4.

Meat and Poultry Inspection Program

The Consumer and Marketing Service, U. S. Department of Agriculture (USDA), began obtaining data on chemical residue levels in meat in 1965 and

TABLE 1. MONITORING RESIDUES IN FOOD AND FEED--MARKET BASKET PROGRAM

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FOOD CLASS I	Chemical	Number of Positive Composites by Region and Fiscal Year(a)													
		Boston							Kansas City						
		1965	1966	1967	1968	1969	1970	1971	1965	1966	1967	1968	1969	1970	1971
Dairy Products	DDT	[illegible]	6	4	[illegible]	3	4	4	4	6	5	6	4	6	3
	DDE	4	6	3	[illegible]	5	6	5	4	6	5	6	5	6	3
	TDE	2	3	2	4	4	6	2	3	5	6	6	1	3	3
	Dieldrin	3	4	3	2	[illegible]	4	5	3	6	5	1	6	6	5
	Heptachlor Epoxide	3	3	4	3	6	4	5	3	6	3	5	6	5	1
	BHC		1	6	[illegible]	1	2	4	4	5	1	5	4	5	4
	Total Bromides(g)	5	7	6	3	5	5	1	6	6	6	5	3	4	1
	Cadmium					1	5	1						1	
	Methoxychlor						2			3	1	1		2	2
	Aldrin									1					
	Lindane	1				1			1	1	1			1	2
	[illegible]		1		1	1				2					
	PCP		1	1	1	2				1	1				1
	2,4-DB														
	2,4,5-TP		2												
	2,4,5-T			1	1						1				
	Heptachlor										1				
	Arsenic			1		1	2				1	1			
	Kelthane														
	2,4-D														
	PCNB				1										
	2,3,6-TBA														
	Ronnel											1			
	Diazinon														
	PCB														
	HCB							1							1
	Total	20	26	31	30	26	37	23	30	47	37	39	29	39	20

FOOD CLASS I	Chemical	Los Angeles							Baltimore					
		1965	1966	1967	1968	1969	1970	1971	1966(b)	1967	1968	1969	1970	1971
Dairy Products	DDT	2	4	3	6	6	4	3	3	6	6	6	4	1
	DDE	6	6	3	6	5	6	6	3	4	6	4	6	4
	TDE	1	2	3	5	4	2	2	2	5	6	4	4	1
	Dieldrin	4	5	3	5	5	4	6	2	3	2	1	1	5
	Heptachlor Epoxide	2	1	2	3	[illegible]	1	2	3	2	5	2	1	2
	BHC		1		2	4	4	2			1		1	3
	Total Bromides(g)	6	6	6	6	4	5	2	6	6	5	5	3	2
	Cadmium				1	3	1	1			1	2	5	1
	Methoxychlor												2	
	Aldrin									1				
	Lindane				1	1					1		1	
	[illegible]										2			
	PCP					1				1	1			
	2,4-DB		1											
	2,4,5-TP													
	2,4,5-T													
	Heptachlor													
	Arsenic													
	Kelthane				1									
	2,4-D													
	PCNB													
	2,3,6-TBA										2			
	Ronnel													
	Diazinon													
	PCB												1	
	HCB							2						
	Total	21	25	26	33	31	27	26	18	26	32	22	27	19

FOOD CLASS I	Chemical	Minneapolis						National Totals						
		1966(b)	1967	1968	1969	1970	1971	1965(d)	1966(e)	1967(f)	1968(f)	1969(f)	1970(f)	1971(f)
Dairy Products	DDT	(c)	5	4	5	5	1	20	27	22	33	20	33	16
	DDE	(c)	5	6	6	5	2	16	20	26	27	33	27	20
	TDE	(c)	3	3	6	3	1	6	12	17	22	30	22	9
	Dieldrin	(c)	3	2	6	5	3	20	16	19	24	27	35	16
	Heptachlor Epoxide	(c)	5	6	6	6	3	8	16	15	28	27	17	16
	BHC	(c)	5	6	5	6	1	4	7	12	23	26	16	16
	Total Bromides(g)	4	6	4	6	5	1	17	36	30	34	25	27	7
	Cadmium			1	2	3	1				3	19	26	6
	Methoxychlor		1	1			1							3
	Aldrin													
	Lindane					1								3
	[illegible]								2		3	1		
	PCP			1					3	1	3	1		5
	2,4-DB								1					
	2,4,5-TP								2					
	2,4,5-T								2					
	Heptachlor				1					1		1		
	Arsenic				1					2	3	3	3	
	Kelthane													
	2,4-D		1							1				
	PCNB										1			
	2,3,6-TBA										2			
	Ronnel										1			
	Diazinon				1							3		
	PCB												1	
	HCB													4
	Total	6	32	36	40	30	16	80	118	166	190	200	203	110

(a) Sampling is bimonthly, 6 composites examined per region per year
(b) Four composite samples examined FY 1966
(c) None examined
(d) Total of 10 composites examined per pesticide
(e) Total of 20 composites examined per pesticide
(f) Total of 30 composites examined per pesticide
(g) Analysis discontinued after October, 1970
(h) Analysis initiated after October, 1970

FOOD CLASS II	Chemical	Number of Positive Composites by Region and Fiscal Year(a)													
		Boston							Kansas City						
		1965	1966	1967	1968	1969	1970	1971	1965	1966	1967	1968	1969	1970	1971
Meat, Fish, and Poultry	DDT	6	6	5	2	5	6	6	6	6	6	6	6	6	6
	DDE	6	5	6	6	5	6	6	6	6	6	6	6	6	6
	TDE	4	5	6	5	3	6	5	5	6	6	6	4	6	4
	Dieldrin	6	3	1	[illegible]	2	5	6	1	5	6	6	[illegible]	5	4
	Heptachlor Epoxide	5	3	3	[illegible]	3	6	5	5	6	6	6	6	6	5
	BHC		6	2	2	2	1	5	5	5	6	4	6	4	2
	Lindane	3	2	1	1	2	5	1			2	1		2	3
	Total Bromides(g)	4	6	5	[illegible]	[illegible]		[illegible]	6	1	6	5	1	4	
	Arsenic			6	[illegible]	6		[illegible]		1	1	1		1	2
	Cadmium					6		6				1	4	4	3
	Aldrin					1			1						
	Diazinon									1					
	Endrin								1						
	Heptachlor					1			1						
	PCP		2			1			2		1				
	Ronnel									1					
	Tetradifon														
	Phorate			1	1										
	2,4,5-T			1											
	Toxaphene														
	Malathion					1									
	MCP														
	HCB														
	2,4-DB														
	PCB's														
	Mercury(h)							1							1
	Total	34	40	[illegible]	[illegible]	[illegible]	[illegible]	42	30	40	46	40	33	44	36

FOOD CLASS II	Chemical	Los Angeles							Baltimore					
		1965	1966	1967	1968	1969	1970	1971	1966(c)	1967	1968	1969	1970	1971
Meat, Fish, and Poultry	DDT	4	6	6	6	6	6	5	3	3	6	6	4	5
	DDE	6	6	6	6	6	6	6	4	5	5	6	4	6
	TDE	4	5	6	6	6	4	3	2	6	6	2	3	3
	Dieldrin	4	3	4	6	6	6	6	1	2	3	1	1	4
	Heptachlor Epoxide	4	6	2	3		1	2	1		2			3
	BHC	1	1	7	5	6	6	2			1		1	
	Lindane	1	4	1	2	2	1	1			1			
	Total Bromides(g)	6	5	5	5	2	5	2	$6^{(e)}$	6	5	3	4	2
	Arsenic	1	5	6	6	6	6	2			4	4	4	2
	Cadmium				1	6	4	2			1	5	5	3
	Aldrin									1				
	Diazinon													
	Endrin					1								
	Heptachlor													
	PCP		1	1		1								
	Ronnel													
	Tetradifon		1											
	Phorate													
	2,4,5-T													
	Toxaphene				1	1								
	Malathion													
	MCP											1		
	HCB						2	1						
	2,4-DB													
	PCB's						2							
	Mercury(h)							3						1
	Total	31	40	32	47	43	43	35	13	23	26	26	26	29

FOOD CLASS II	Chemical	Minneapolis						National Totals						
		1966(b)	1967	1968	1969	1970	1971	1965(d)	1966(e)	1967(f)	1968(f)	1969(f)	1970(f)	1971(f)
Meat, Fish, and Poultry	DDT	1	5	6	6	6	6	30	32	27	26	30	30	30
	DDE	1	5	6	6	6	6	18	33	28	27	27	30	30
	TDE	1	4	4	6	6	3	13	19	28	27	31	33	20
	Dieldrin		3	6	6	6	3	13	20	26	18	30	33	23
	Heptachlor Epoxide		4	2	6	6	5	12	16	13	15	19	16	18
	BHC		6	2	3	3		6	12	13	16	16	15	7
	Lindane		1	1	6	4		4	3	9	6	8	10	[illegible]
	Total Bromides(g)	$3^{(e)}$	5	5	5	3	3	16	23	27	25	30	23	7
	Arsenic				3		1			9	16	33	36	9
	Cadmium			1	5	6	5				6	31	30	27
	Aldrin							1		1		1		
	Diazinon				1	1			1			1	1	
	Endrin							1						
	Heptachlor			1	1			1			1	2		
	PCP			1				2	3	2	1	2		
	Ronnel								1					
	Tetradifon								1					
	Phorate									1	1			
	2,4,5-T									1				
	Toxaphene										1	1		
	Malathion											1		
	MCP											1		
	HCB												2	
	2,4-DB					1							1	
	PCB's					1							2	
	Mercury(h)													10
	Total	8	31	32	37	23	26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(a) Sampling is bimonthly, 6 composites examined per region per year
(b) Four composite samples examined FY 1966
(c) Five composite samples examined FY 1966
(d) Total of 18 composites examined per pesticide
(e) Total of 26 composites examined per pesticide, 28 for total bromides
(f) Total of 33 composites examined per pesticide
(g) Analysis discontinued after October, 1970
(h) Analysis initiated after October, 1970

TABLE 1. (Continued)

Number of Positive Composites by Region and Fiscal Year(a)

FOOD CLASS III	Chemical	Boston							Kansas City							Los Angeles							Baltimore						Minneapolis						National Totals						
		1965	1966	1967	1968	1969	1970	1971	1965	1966	1967	1968	1969	1970	1971	1965	1966	1967	1968	1969	1970	1971	1966(b)	1967	1968	1969	1970	1971	1966(b)	1967	1968	1969	1970	1971	1965(d)	1966(e)	1967(f)	1968(f)	1969(f)	1970(f)	1971(f)
Grain and Cereal	DDT	4	5	3	5	5	5	4	5	[illegible]	2	5	3	2		5	3	6	4	6	1	2	1	4	3	3	3	2				5	3	3	16	16	13	17	22	18	30
	DDE		2	1	4	1	1	1	1	4	1	2	4	2		2	2		5	1	1		2					2				3	2		5	14	2	11	13	20	3
	TDE		1		1	2	6	1	1	1	1	1	1	1		1	1	3	3	2	1		1					1				3	6	3	6	6	4	5	8	10	5
	Dieldrin	1	1	2	1	3	2	1	1	5	4		1	1	1	1	2	2	2	3	2		1	1	2	1		1				3	2	1	3	9	9	5	13	7	4
	Lindane	6	5	5	3	5	2		6	6	5	5	4	3		6	3	6	5	3	2	2	3	1	2	2	2		3	5	2	3	6	1	16	20	21	17	17	13	3
	Malathion		1		1	2	4	4		4	6	4	4	5	5		4	1		3	6	6		2	1		5	6	2	1		4	5	6		11	8	6	13	24	20
	Total Bromides(e)	6	6	6	6	6	6	2	6	6	6	5	6	6	1	6	6	6	6	4	6	2	4(c)	6	5	6	6	2	5(c)	4	6	3	5	1	18	27	28	28	27	27	8
	Arsenic	1		2	1	4						1					1	1		1					3							2			1	1	3	5	7		
	Cadmium					5	5	5				1	4	4	5				2	5	6	6				6	6	5			1	5	6	6				6	27	27	27
	Diazinon				1		3			2				1	6					1	1	6						2	2			2	2	2		4		1	3	9	12
	Aldrin	1		1	1	2								1			1						1												1	2	1	1	2	1	
	BHC			1						1		1		1	1					1		2														1	1	1	1	1	3
	Carbaryl							2	3		1											1													3		1				3
	Dithiocarbamate(g)								1																										1						
	Endrin		1														1																			2					
	Heptachlor								1							1																1			2				1		
	Heptachlor Epoxide		1				1	2		2			1	2				1	2													1	1			3	1	2	2	4	2
	HCB	1																																	1						
	Methoxychlor		1		1					1			1																					1		2		1	1		1
	PCNB		1																																	1					
	PCP		1			1			1	1										1				1						1	2				1	2	2	2	2		
	Perthane									2																2										2			2		
	[illegible]									1																										1					
	Ronnel									1		1	1		1																					1		1	1		1
	Kelthane				1							1																										2			
	Chlorbenside				1																																	1			
	Methyl Parathion					1																																	1		
	TCNB				1	1																																1	1		
	Parathion																				1																			1	
	PCB						1								1																			1							4
	o-Phenylphenol(h)																					1																			1
	Total	19	26	21	28	40	37	22	[illegible]	44	26	27	30	27	19	20	24	26	29	29	29	27	13	15	16	18	22	21	12	11	11	45	36	25	68	119	95	111	164	150	115

(a) Sampling is bimonthly, 6 composites examined per region per year
(b) Four composite samples examined FY 1966
(c) Five composite samples examined FY 1966
(d) Total of 18 composites examined per pesticide
(e) Total of 26 composites examined per pesticide, 28 for total bromides
(f) Total of 30 composites examined per pesticide
(g) Analysis discontinued after October, 1970
(h) Analysis initiated after October, 1970

Number of Positive Composites by Region and Fiscal Year(a)

FOOD CLASS IV	Chemical	Boston							Kansas City							Los Angeles							Baltimore						Minneapolis						National Totals						
		1965	1966	1967	1968	1969	1970	1971	1965	1966	1967	1968	1969	1970	1971	1965	1966	1967	1968	1969	1970	1971	1966(b)	1967	1968	1969	1970	1971	1966(b)	1967	1968	1969	1970	1971	1965(d)	1966(e)	1967(f)	1968(f)	1969(f)	1970(f)	1971(f)
Potatoes	DDT		4	4	4	5	4	2				2	1	1		1	1	2	2	1	2	2	1	1	2	2	4	1		1		1	3	1(d)	1	6	8	10	10	16	5
	DDE		1	6	2	4	5	2		1	1	2	1	3	2	6	1	2	3	2	3	1	1	1	1	1	5	1		1			3	2	4	4	9	8	6	19	8
	Dieldrin		1	1		2	1	2	1	3		2	3	1	3	1	3	1		5	3	2		1	1		2	1				1	3	2	2	7	3	3	11	10	10
	Total Bromides(b)	5	5	6	6	5	1	2	6	6	5	5	6	1		4	3(d)	6	6	4			3(c)	6	6	4	4	2	5(c)	4	4	4	5	2	15	22	25	25	21	13	6
	Endrin			2	1	1	6	1				1				2(d)	1	2	1	5	1	1								1		5			2	1	5	3	11	5	2
	Arsenic			2	1	1	1				1						1		2	1					4						1	1	1	1		1	3	8	3	2	1
	Cadmium					6	5	5				1	5	6	6				3	5	6	6			1	5	6	5			1	5	6	6				6	26	27	30
	BHC							1																			2													2	1
	Carbaryl							1							1																										2
	[illegible]										1											1											1				1			1	1
	Heptachlor Epoxide					2	1		2(d)	2(d)			1							1					1										2	2		1	6	1	
	Lindane	1		1	1					2							1	1		2			1												1	6	2	1	2	1	
	Parathion																1				1															1				1	
	TCNB	1					1																1													1			1	3	
	TDE			1	2			1								1	1	3	2								1					1			1	1	4	4	1	1	1
	PCP			1																											1				1		1	1			
	Phorate				1																																	1			
	Chlordane						1						1							1																			2	1	
	Endosulfan Sulfate																															2							2		
	Diazinon																			1	1											1							2	2	
	2,4-D																																							1	
	Aldrin				1																													1				1			
	Endosulfan (Total)						1	1														1											2							3	2
	Botran																											1													1
	Total	7	11	22	17	25	31	10	9	12	8	13	16	12	12	13	13	15	19	20	17	13	7	9	16	12	25	11	5	7	7	21	25	15	29	48	61	72	102	110	68

(a) Sampling is bimonthly, 6 composites examined per region per year
(b) Four composite samples examined FY 1966
(c) Five composite samples examined FY 1966
(d) Total of 18 composites examined per pesticide
(e) Total of 26 composites examined per pesticide, 28 for total bromides
(f) Total of 30 composites examined per pesticide
(g) Analysis discontinued after October, 1970
(h) Analysis initiated after October, 1970

TABLE 1. (Continued)

(a) Sampling is bimonthly, 6 composites examined per region per year
(b) Four composite samples examined FY 1966
(c) Five composite samples examined FY 1966
(d) Total of 18 composites examined per pesticide
(e) Total of 20 composites examined per pesticide, 28 for total bromides
(f) Total of 30 composites examined per pesticide
(g) Analysis discontinued after October, 1970
(h) Analysis initiated after October, 1970

(a) Sampling is bimonthly, 6 composites examined per region per year
(b) Four composite samples examined FY 1966
(c) Five composite samples examined FY 1966
(d) Total of 18 composites examined per pesticide
(e) Total of 20 composites examined per pesticide, 28 for total bromides
(f) Total of 30 composites examined per pesticide
(g) Analysis discontinued after October, 1970
(h) Analysis initiated after October, 1970

TABLE 1. (Continued)

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FOOD CLASS VII	Chemical	Number of Positive Composites by Region and Fiscal Year(a)																																							
		Boston							Kansas City							Los Angeles							Baltimore						Minneapolis						National Totals						
		1965	1966	1967	1968	1969	1970	1971	1965	1966	1967	1968	1969	1970	1971	1965	1966	1967	1968	1969	1970	1971	1966(b)	1967	1968	1969	1970	1971	1966(c)	1967	1968	1969	1970	1971	1965(d)	1966(e)	1967(f)	1968(f)	1969(f)	1970(f)	1971(f)
Root vegetables	DDT	1			1	2	5	2	2	2	2		3	2		2	2			3	3	2		2	1	1	2					3	4		5	4	6	2	12	20	6
	DDE	1			1	1	5	1	2	4	1	2	3	1	1	4	4	2	1	5	3	3		3	1	1	2			1	1	2	3	1	7	8	7	6	13	18	6
	Dieldrin	1				1	3	1	1	4		1	2	2		1	3																	1	3	7		1	3	9	2
	Total Bromides(g)	5	4	6	3	4	3	2	6	5	6	3	3	2	1	3	5	4	4	3	4	1	3(e)	6	6	4	5	2	4(e)	4	4	6	5	1	14	21	20	20	18	19	7
	TDE					1	2		1	1	1							2		1				2			1	2		1			1		2	1	6		2	6	8
	Cadmium					5	5	5				1	4	6	2				2	5	6	5				5	6	6			1	5	6	6				4	26	27	26
	Carbaryl								1	1												2		1											1	1	1				2
	Chlorbenside									1																										1					
	Endrin						1		1	1								1																	1	1	1			1	
	Malathion									1																										1					
	TCNB								1								1																		1	1					
	Arsenic	1		2		2								1				1							2				1						1	1	3	2	2	1	
	Lindane				1			1				1		1								1																2		3	2
	Heptachlor Epoxide				1																																	1			
	Phorate				1																																	1			
	Heptachlor																															2							2		
	Toxaphene																			1		1																	1		1
	Dithiocarbamates(g)																							1									3				1			3	
	Aldrin																															1							1		
	Orthophenylphenol(h)																											2													
	Total	9	4	8	8	16	24	[illegible]	15	20	10	8	15	15	4	11	15	10	7	18	16	15	3	15	10	11	16	12	5	6	6	20	24	8	35	47	45	39	79	97	60

(a) Sampling is bimonthly, 6 composites examined per region per year
(b) Four composite samples examined FY 1966
(c) Five composite samples examined FY 1966
(d) Total of 18 composites examined per pesticide
(e) Total of 24 composites examined per pesticide, 20 for total bromides
(f) Total of 30 composites examined per pesticide
(g) Analysis discontinued after October, 1970
(h) Analysis initiated after October, 1970

FOOD CLASS VIII	Chemical	Number of Positive Composites by Region and Fiscal Year(a)																																							
		Boston							Kansas City							Los Angeles							Baltimore						Minneapolis						National Totals						
		1965	1966	1967	1968	1969	1970	1971	1965	1966	1967	1968	1969	1970	1971	1965	1966	1967	1968	1969	1970	1971	1966(b)	1967	1968	1969	1970	1971	1966(c)	1967	1968	1969	1970	1971	1965(d)	1966(e)	1967(f)	1968(f)	1969(f)	1970(f)	1971(f)
Garden fruits	DDT	3	4	1	4	2	6	2	4	4	6	5	6	2	3	5	6	6	5	6	6	3	2	4	3	2	6	2	2	3	1	4	6	1	12	18	20	20	20	20	11
	DDE	1	2		3	1	5		1	4	2	4	3	4	2	6	3	3	5	3	3	2	2	2	1		4	1		3		4	3		8	11	10	13	13	19	9
	TDE	3	3		3	1	4	2	2	6	5	5	4	5	6	3	2	4	2	3	4	3	1	3	5	3	5	4	2	3	2	6	8	6	8	14	15	17	17	26	10
	Dieldrin	2	1	1	2	2	4	5	2	3	1	3	3	2	4	6	2	2	3	4	4	6	1			1	3	2	2	1	2	1	3	3	8	9	5	10	11	20	10
	Lindane	2	1	1	2	1	1		3	4	1	2	1	3	1	2	2	1	3	2		1	1		1				2		1	2	1	2	7	12	6	9	6	9	5
	Total Bromides(g)	5	5	6	6	4	5	1	6	6	6	3	3	3	1	4	5	6	6	3	3	2	3(e)	6	5	3	5	2	5(e)	6	5	4	4	1	13	24	20	23	17	22	7
	Cadmium					6	5	4				2	3	5	6				2	3	8	6				6	5	5			1	5	6	5				5	25	27	20
	Toxaphene		1														1		2	4	1						1					2				2		2	9	2	
	Parathion						1				1			1						2	1						2	2		2		3		1			3		5	5	9
	Endosulfan (I, II, and Sulfate)						1	1													1	1											3							5	2
	Aldrin		1	2	3		1																													1	2	3		4	
	Arsenic					3	1							2	2				2	1									1							1		6	4	5	
	BHC						1	1	1													1						2					1	1	1					6	2
	Carbaryl							2	1		1											1													1		1				3
	Chlordane	1	1														1			1															1	2					
	Diazinon			1																1	1						1		1			1				1	1		2	2	
	Endrin						1		1	1										2							1								1	1			3	2	
	Heptachlor Epoxide		1	2										1		1															2	1			1	1	2	2		1	
	Endosulfan		2										1				1		1	2												1				3		1	4		
	TCNB			1	1																																1	1			
	Dacthal																			1												2							2		
	PCP																			1																			1		
	Malathion																				1																		1	1	
	Orthophenylphenol(h)																											1													1
	Kelthane														1																										1
	Total	17	24	19	22	20	40	18	21	28	22	24	24	28	28	23	23	22	31	43	33	26	10	15	19	13	33	21	15	16	14	36	35	17	63	100	94	110	135	140	106

(a) Sampling is bimonthly, 6 composites examined per region per year
(b) Four composite samples examined FY 1966
(c) Five composite samples examined FY 1966
(d) Total of 18 composites examined per pesticide
(e) Total of 24 composites examined per pesticide, 20 for total bromides
(f) Total of 30 composites examined per pesticide
(g) Analysis discontinued after October, 1970
(h) Analysis initiated after October, 1970

TABLE 1. (Continued)

Class II	Chemical	Number of Positive Composites by Region and Fiscal Year(a)													
		Boston							Kansas City						
		1965	1966	1967	1968	1969	1970	1971	1965	1966	1967	1968	1969	1970	1971
Fruits	DDT	3	4	3	6	5	1	1	1	1	2	6	4	3	
	DDE	2	2	3	5	4	5	2	1	6	2	3	2	4	2
	TDE			1		2	2	4		1	2		2		1
	Aldrin	6	3	1	1				1						
	Kelthane		3	5	3			2	1	6	3	5			3
	Total Bromides(b)	2	3	5	5	3	3	2	6	6	6	6	2	4	
	Lindane		2						1		1	1			
	Cadmium					4	9	1					3	1	1
	Dicofol					1	2						3	3	
	Ethion		1	1	1	1	1	2			1	2	2	2	5
	Arsenic	3		1	1	2	1	1			1				
	Dieldrin	1(d)	2(d)	1		1	4	1		3			1	2	
	Malathion													2	1
	Carbaryl		1					1	2	2	1				
	Dacthal		1												
	PCNB								1						
	Perthane	1	1		1			4							
	Tetradifon	1													
	Endosulfan									1					
	BHC											1		2	
	Meth.oxychlor			1											
	Heptachlor Epoxide			1	1										
	Tedion				1										
	2,4-D				1										
	Ovex														
	Orthophenylphenol(i)													1	1
	Parathion														
	Endosulfan (I, II, and Sulfate)							1							
	Diazinon														1
	Botran														
	Phosalone							1							
	Total	15	25	27	26	25	26	22	14	26	21	21	19	26	13

Class II	Chemical	Los Angeles							Baltimore					
		1965	1966	1967	1968	1969	1970	1971	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fruits	DDT	5	2	3	6	6	5	3	3	2	3	1	3	
	DDE	3	3	5	4	4	2	2	3		2	1	3	
	TDE	1	1	3	3	2	1	1	3	3		2	3	
	Aldrin	3	1						2	2				
	Kelthane		2	5	6			4	1(a)	1	2			1
	Total Bromides(b)	6	3	6	6	2	2	1	1	6	6	6	6	2
	Lindane		2			1		1						
	Cadmium				1	2	3	1				6		1
	Dicofol					6	5							
	Ethion					1	6	3			1		2	2
	Arsenic			1	2						3			1
	Dieldrin							1					1	
	Malathion						2	3						
	Carbaryl		1					3						2
	Dacthal													
	PCNB													
	Perthane							1			1			
	Tetradifon	1	1											
	Endosulfan													
	BHC			1										
	Meth.oxychlor												1	
	Heptachlor Epoxide													
	Tedion													
	2,4-D													
	Ovex													
	Orthophenylphenol(i)							3						
	Parathion												1	
	Endosulfan (I, II, and Sulfate)						1	1						
	Diazinon						1						1	
	Botran													
	Phosalone													
	Total	19	16	22	22	15	20	20	13	13	16	14	17	8

Class II	Chemical	Minneapolis						National Trends						
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fruits	DDT		2	1	6	3	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	DDE		2		2	6	3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	TDE		2	1	3	3	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Aldrin		2	2				[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Kelthane		2	1			1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Total Bromides(b)	4(e)	3	3	3	6	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Lindane							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Cadmium			1	2	1		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Dicofol				3	3		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Ethion		1	2	2	6	3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Arsenic			1	1			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Dieldrin				1	6		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Malathion				1	3	3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Carbaryl				1		1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Dacthal							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	PCNB							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Perthane							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Tetradifon							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Endosulfan				2			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	BHC							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Meth.oxychlor							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Heptachlor Epoxide				2			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Tedion							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	2,4-D							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Ovex				1			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Orthophenylphenol(i)						3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Parathion							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Endosulfan (I, II, and Sulfate)					[illegible]	3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Diazinon					1		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Botran						1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Phosalone							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Total	4	13	12	29	24	22	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(a) Sampling is bimonthly, 6 composites examined per region per year
(b) Four composite samples examined FY 1966
(c) Five composite samples examined FY 1966
(d) Total of 19 composites examined per pesticide
(e) Total of 26 composites examined per pesticide, 28 for total bromides
(f) Total of 30 composites examined per pesticide
(g) Analysis discontinued after October, 1970
(h) Analysis initiated after October, 1970

Class I	Chemical	Number of Positive Composites by Region and Fiscal Year(a)													
		Boston							Kansas City						
		1965	1966	1967	1968	1969	1970	1971	1965	1966	1967	1968	1969	1970	1971
[illegible], Oats, and [illegible]	DDT	1	3	1	3		4	5	2	5		2	3	3	3
	DDE	1	2	1	3	1	6	5	2	6	1	2	3	4	4
	TDE	1	2	1	6	1	3	2	2	5	1	2	3	2	3
	Heptachlor Epoxide	1			1	1	1	2	3	3	6	5	1	1	
	Total Bromides	6	5	6	3	6	6	6	1(e)	2(e)	2	2	5	2	4
	Dieldrin					2	1		1				2	2	
	BHC			1			1						2		
	Malathion		1	1	2	2	1	1		2	1	1		2	2
	Cadmium					6	5	6				1	5	5	6
	Aldrin								1	1		1			
	Endrin								1	1					
	Heptachlor								1			2			
	Lindane						1		1				1	1	
	PCP		1												
	Arsenic			1		1									
	Ethion			1											
	Diazinon			1											
	Chlorbenside											1			
	PCNB				1							1			
	Endosulfan														
	Parathion														
	HCB														
	2,4-DB														
	Endosulfan (I, II plus Sulfate)									1					
	Perthane														
	2,4-D	1													
	TBA								1						
	Total	11	16	14	10	20	28	27	16	10	11	20	25	22	22

Class I	Chemical	Los Angeles							Baltimore				
		1965	1966	1967	1968	1969	1970	1971	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible], Oats, and [illegible]	DDT	1	2	2	1	3		6	2	6	3	1	
	DDE	1	3	2	1	1	1	2	3	6	1		1
	TDE	1	3	2	3	2		4	1	2	1		
	Heptachlor Epoxide	1	2	6	3	3	5						
	Total Bromides	2(e)	2(e)		1	1	1	1(d)	3(e)	5	5	3	6
	Dieldrin					2	2						
	BHC							2					
	Malathion				2	5	6	6		4		3	6
	Cadmium												
	Aldrin		1										
	Endrin												
	Heptachlor	1		1	2	2				1			
	Lindane		1			1				1			
	PCP			1	2						1		
	Arsenic												
	Ethion												
	Diazinon												
	Chlorbenside												
	PCNB												
	Endosulfan					1							
	Parathion						3						
	HCB												
	2,4-DB												
	Endosulfan (I, II plus Sulfate)												
	Perthane												
	2,4-D												
	TBA												
	Total	12	14	12	15	20	18	19	9	18	11	9	12

Class I	Chemical	Minneapolis						National Trends						
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible], Oats, and [illegible]	DDT		6		2	1	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	DDE		3		6	2	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	TDE		6	1	6	1	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Heptachlor Epoxide							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Total Bromides	3(e)	6	3	5	6	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Dieldrin				1	1	5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	BHC				1	2		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Malathion	1	1	1	3	2	3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Cadmium				6	6	5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Aldrin							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Endrin					1		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Heptachlor		1					[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Lindane				1			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	PCP				1			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Arsenic				1	1		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Ethion							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Diazinon							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Chlorbenside							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	PCNB							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Endosulfan					1		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Parathion					1		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	HCB							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	2,4-DB					1		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Endosulfan (I, II plus Sulfate)							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Perthane							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	2,4-D							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	TBA							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Total	6	10	5	29	26		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(a) Sampling is bimonthly, 6 composites examined per region per year
(b) Four composite samples examined FY 1966
(c) Five composite samples examined FY 1966
(d) Total of 19 composites examined per pesticide
(e) Total of 26 composites examined per pesticide, 28 for total bromides
(f) Total of 30 composites examined per pesticide
(g) Analysis discontinued after October, 1970
(h) Analysis initiated after October, 1970

TABLE 1. (Continued)

FOOD CLASS XI	Chemical	Number of Positive Composites by Region and Fiscal Year(a)																																							
		Boston							Kansas City							Los Angeles							Baltimore						Minneapolis						National Totals						
		1965	1966	1967	1968	1969	1970	1971	1965	1966	1967	1968	1969	1970	1971	1965	1966	1967	1968	1969	1970	1971	1966(b)	1967	1968	1969	1970	1971	1966(b)	1967	1968	1969	1970	1971	1965(d)	1966(e)	1967(f)	1968(f)	1969(f)	1970(f)	1971(f)
Sugars and adjuncts	2,4-D		7						6	6	1					4	3	1												3	2				8	8	5	2			
	Total Bromides(b)	6	6	6	6	4	4	1	6	6	3	5	3	4	2	6	5	1	6	3	3	1	3(c)	6	6	4	5	2	5(c)	5	4	5	5	1	18	25	23	27	29	23	8
	Lindane		1	2	4	1		2	1	1				2	1	1		1	2	1	4	2			1							2	2	3	2	2	3	7	5	10	8
	Arsenic		1	3	1	1												1	3						2	1		1				1				1	6	6	5		1
	DDT			2	1	2	4	4	2					1	1	1(d)	2(d)	1		2	2	1				1	1				1	3	4	3	3	2	3	2	8	16	9
	DDE			1	1	2	6	3						1		1(d)	2(d)			2	2	3		1						1		2	3	2	1	2	3	1	6	12	8
	Cadmium					4	5	3					3	1	3				3	5	5	3				3	4	2			1	3	3	3				4	18	18	14
	TDE				2		3	4						1		2			2	2		1								1		1	3	2	2		1	6	2	7	6
	Aldrin				2		1		1															1											1		1	2		1	
	BHC							2	1													2												2	1						6
	Carbaryl								2	2																									2	2					
	Dieldrin					1	1									1	1			1													1		1	1			2	2	
	Heptachlor Epoxide						1	1		1						2																		1	2	1				1	2
	MCP		1																	1																1			1		
	Ronnel																1																			1					
	PCP										1				1					1																	1		1		1
	Malathion																				1	1		1													1			1	1
	Kelthane			1																																					
	Heptachlor																																					1			
	Dithiocarbamates(g)																		1																			1			
	PCB																				1																			1	
	Diazinon																																	1							1
	Total	6	13	15	16	15	21	20	17	14	7	5	6	10	8	18	14	7	17	18	20	14	3	9	9	9	10	5	5	10	8	17	21	18	41	46	47	57	88	72	65

a) Sampling is bimonthly, 6 composites examined per region per year
b) Four composite samples examined FY 1966
c) Five composite samples examined FY 1966
d) Total of 18 composites examined per pesticide
e) Total of 26 composites examined per pesticide, 29 for total bromides
f) Total of 30 composites examined per pesticide
g) Analysis discontinued after October, 1970
h) Analysis initiated after October, 1970

FOOD CLASS XII	Chemical	Number of Positive Composites by Region and Fiscal Year(a)																																							
		Boston							Kansas City							Los Angeles							Baltimore						Minneapolis						National Totals						
		1965	1966	1967	1968	1969	1970	1971	1965	1966	1967	1968	1969	1970	1971	1965	1966	1967	1968	1969	1970	1971	1966(b)	1967	1968	1969	1970	1971	1966(b)	1967	1968	1969	1970	1971	1965(d)	1966(e)	1967(f)	1968(f)	1969(f)		1971(f)
Beverages	Total Bromides(b)	1	4	6	[illegible]	2			5	1	4	2	[illegible]	3	1	2		2	4	2	2	1	1(c)	5	3	3	3	2	3(c)	2	4	4	6	1(g)	10	9	19	18	16	17	5
	Arsenic			1	2	[illegible]						1							2						1	1											1	5	3		
	Cadmium					[illegible]	4						1	1	1				2	1	2	1				3	2	1			1	1						3	8	9	3
	Carbaryl								1	1																									3	1					
	DDE				1											1																			1			1			
	Heptachlor Epoxide									1																										1					
	Lindane			1	1					1												1														1	1	1			1
	PCP		1	1																																1	1				
	Malathion																							1													1				
	DDT					1	1	1																															1	1	1
	TDE						1	1																																1	1
	Total	1	5	9	9	[illegible]	11	2	6	4	4	3	4	4	2	3		2	8	3	4	3	1	6	4	7	5	3	3	2	5	5	6	1	14	13	23	28	28	28	11

a) Sampling is bimonthly, 6 composites examined per region per year
b) Four composite samples examined FY 1966
c) Five composite samples examined FY 1966
d) Total of 18 composites examined per pesticide
e) Total of 26 composites examined per pesticide, 28 for total bromides
f) Total of 30 composites examined per pesticide
g) Analysis discontinued after October, 1970
h) Analysis initiated after October, 1970

Source: Duggan et al (1967); Martin and Duggan (1968); Corneliussen (1969, 1970, 1972, 1976).

TABLE 2. FOOD AND DRUG ADMINISTRATION REGIONAL AND DISTRICT OFFICES

Region Number	Regional Offices	District Offices
1	Boston, Massachusetts	Boston, Massachusetts
2	Brooklyn, New York	Brooklyn, New York
		Buffalo, New York
		Newark, New Jersey
		San Juan, Puerto Rico
3	Philadelphia, Pennsylvania	Philadelphia, Pennsylvania
		Baltimore, Maryland
4	Atlanta, Georgia	Atlanta, Georgia
5	Chicago, Illinois	Chicago, Illinois
	Cincinnati, Ohio	Cincinnati, Ohio
	Detroit, Michigan	Detroit, Michigan(a)
	Minneapolis, Minnesota	Minneapolis, Minnesota
6	Dallas, Texas	Dallas, Texas
	New Orleans, Louisiana	New Orleans, Louisiana
7	Kansas City, Missouri	Kansas City, Missouri
8	Denver, Colorado	Denver, Colorado
9	San Francisco, California	San Francisco, California
		Los Angeles, California
10	Seattle, Washington	Seattle, Washington

(a) Only district not reporting residue levels through its consumer specialist offices.

TABLE 3. CHEMICALS AND METALS MONITORED BY THE MARKET BASKET PROGRAM AS OF FY 1973

Dieldrin
DDE
DDT
TDE
BHC
Heptachlor Epoxide
Diazinon
Malathion
PCB
Lindane
Endrin
Methoxychlor
CIPC
Parathion
Methyl Parathion
Ronnel
HCB
Perthane
Thiodan I
Thiodan II
Thiodan SO_4
Botran
Lead

Cadmium
Zinc
Arsenic (AS_2O_3)
Selenium
Mercury
Toxaphene
Kelthane
Carbaryl (Sevin)
Ethion
Orthophenylphenol
Aldrin
Heptachlor
PCNB
PCA
PCP (pentachlorophenol)
TCNB
Dursban
2,4-D
Dacthal
Strobane
Chlordane
Phosalone

Source: Corneliussen, personal communication (1974).

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TABLE 4. MONITORING RESIDUES IN FOOD AND FEED—SURVEILLANCE PROGRAM: FY 1964-1969

Chemicals Monitored	Food Class (Monitoring is Continuous)																
	Dairy Products	Large Fruits	Small Fruits	Grains(b) and Cereals(Human)	Leaf and Stem Vegetables	Vine and Ear Vegetables	Root Vegetables	Beans	Eggs	Fish	Shellfish	Grains(j) (Animal)	Infant and Junior Foods	Tree Nuts	Vegetable Oil Products	Meats	Poultry(i)
DDT	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
DDE	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
TDE	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Lindane	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Dieldrin	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Aldrin	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x(e)	x
Heptachlor Epoxide	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x(g)	x
BHC	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x(d)	x
Heptachlor	x			x			x			x	x					x	x
Methoxychlor	x			x	x											x	x
Endrin		x	x	x	x	x	x	x	x	x	x	x		x	x	x	x
Toxaphene		x	x	x	x	x	x	x	x	x				x	x	x	
Endosulfan (Thiodan)		x	x		x	x											
Carbaryl(a)		x		x													
Dicofol (Kelthane)		x	x														
Tetradifon (Tedion)(a)		x	x														
Parathion			x	x	x	x	x	x									
Ethion(a)		x	x														
Diazinon(a)		x		x	x	x	x	x									
Carbophenothion(a)(Trithion)		x															
Perthane			x														
Malathion(a)				x								x(h)					
PCP(a)				x													
Chlordane				x		x	x				x				x		x
PCNB					x												
Chlorbenside (Mitox)					x												
Methyl Parathion(a)					x		x										
DCPA (Dacthal)					x												
MCP																x(f)	
Number of Chemicals Detected	10	17	16	18	18	14	15	12	10	11	11	10	7	10	9	13	12
Number of Samples Examined:	21201	9258	3191	8109	14017	9863	14094	1636	4167	2528	997	1228	2070	546	3492	13820	3414
Domestic	19220	6763	2695	8005	13864	8072	13561	1492	4046	2150	830	1168	2070	418	3492	12146	3414
Imported	1981	2495	496	104	153	1791	533	144	121	378	167	60		128		3676(c)	
Percent With Residues																	
Domestic	53.3	49.7	53.4	33.6	61.0	44.7	50.4	31.0	70.3	74.4	48.3	40.6	25.5	21.3	30.5		
Imported	67.7	54.1	43.8	19.2	52.9	78.2	55.3	80.6	54.5	56.1	16.8	18.3		49.2			

(a) Not included in analytical method FY1964-1965
(b) Includes animal grains FY1964-1965
(c) Import samples for FY1967, 1968, and 1969 only
(d) FY1968 and 1969 only, 4012 domestic samples and 1773 import samples
(e) FY1968 and 1969 only, 1773 import samples
(f) 8134 domestic samples for FY1965, 1966, and 1967 only and 1901 import samples for FY1967 only
(g) FY1967 only, 3098 domestic samples
(h) Not examined for in all samples
(i) FY1968 and 1969 only
(j) FY1966 and 1969 only

Source: Pesticide Monitoring Journal (1968).

for poultry in 1968. The stated purpose of this program is to determine "the incidence of a given residue in the total population and in locating problem herds and flocks "(USDA 1973). As such, the monitoring is largely oriented toward regulation of "violative residues".

Although annual reports are being made to the U. S. Congress beginning with 1972 data, this program does not otherwise report residue findings, incidence of specific pesticides in the total population of animals sampled, or determine trends in residue levels (Spencer 1974).

Currently, inspection takes place at 5,763 meat and poultry slaughter houses across the country (USDA 1973). Samples for pesticide residue analysis, however, are apparently taken from about 1,200 of these slaughtering houses (Duggan and Cook 1971). The samples are examined in 7 laboratories of the Consumer and Marketing Service, USDA (Duggan et al 1971).

Reported data for this program including chemicals monitoried, sample sizes, and years reported are given in Table 5.

Monitoring Residues in Humans

This element of the NPMP has operated continuously since its initiation in 1967 under the auspicies of the United States Public Health Service. The program came under EPA's Community Studies Program, Chamblee, Georgia, in 1970. In 1973 the program was brought under the control of the Ecological Monitoring Branch of the EPA.

The objective of the human monitoring program is to determine on a national scale incidences, levels, and other evidence of exposure of the general population of the United States to pesticides. Additionally, assessment of changes and trends in these parameters are program goals (Yobs 1971). To fulfill this objective, adipose tissue specimens secured through the cooperation of participating pathologists are analyzed for selected pesticides and their metabolites known to be stored in the lipid portion of these tissues (Kutz 1974). Table 6 indicates the chemicals routinely monitored by the program through multi-residue analysis using gas-liquid chromatography. Thin-layer chromatography and mass spectrometry are used to confirm positive detections.

TABLE 3. MONITORING RESIDUES IN FOOD AND FEED--MEAT AND POULTRY INSPECTION PROGRAM

Chemicals Monitored	Fiscal Year (Monitoring is Continuous)														
	Meat								Poultry						
	1965-1967	1968	1969	1970(d)	1971(e)	1972(f)	1973	1974(g)	1968	1969	1970(d)	1971(e)	1972(f)	1973	1974(g)
DDT(a)	x	x	x				x	x	x	x				x	x
Dieldrin	x	x	x		x		x	x	x	x		x		x	x
Heptachlor Epoxide	x(b)	x(c)	x(c)												
Heptachlor	x	x	x				x	x	x	x				x	x
Lindane	x	x	x				x	x	x	x				x	x
BHC		x	x				x	x	x	x				x	x
Aldrin	x	x	x		x		x	x	x	x		x			x
Endrin	x	x	x				x	x	x	x				x	x
Methoxychlor	x	x	x				x	x						x	x
Toxaphene	x	x	x				x	x						x	x
MCP	x														
Chlordane								x	x						x
PCB							x	x						x	x
HCB							x	x						x	x
Calendar Year 1972 Only Chemicals Monitored:															
·Diethylstilbestrol						x									
·Organic Phosphate						x									
·Chlorinated Hydrocarbons						x							x		
·Sulfa Drugs						x							x		
·PCB's						x							x		
·Herbicides						x									
·Arsenic						x							x		
·Heavy Metals						x							x		
·Antibiotics						x							x		
·Nitrosamine						x									
·Mercury						x									
Number of Samples Examined:	10035	3987	1798		2734	19483	1019	1360				1532	5325	1037	890
Domestic	8134	2713	1299						2679	735					
Imported	1901	1274	499												
Number of Plants Examined By Federal Agents Total - 5763(h)	(d)	(d)	(d)	(d)	(d)	3823	(d)	(d)	(d)	(d)	(d)	(d)	738	(d)	(d)

(a) Includes DDT, DDE, and TDE
(b) FY1967 only, 3098 domestic samples and 1901 import samples
(c) Import samples only
(d) Results not available
(e) Results available for Aldrin and Dieldrin only
(f) Calendar Year 1972
(g) First three quarters only
(h) Includes 948 combination meat/poultry plants and 254 plants inspected by State employees

TABLE 6. MONITORING RESIDUES IN HUMANS--CHEMICALS CURRENTLY MONITORED

α BHC
β BHC
γ BHC
δ BHC
o,p'-DDE
p,p'-DDE
o,p'-DDD
p,p'-DDD
o,p'-DDT
p,p'-DDT
Aldrin
Dieldrin
Endrin
Heptachlor
Heptachlor epoxide
Mirex
Oxychlordane
PCB
Trans nonachlor
HCB (Hexachloro benzene)

Source: Strassman, personal communication (1974).

Prior to FY 1970, the samples were not collected according to any particular experimental design (Strassman, personal communication). Instead, pathologists were randomly recruited from selected states to obtain small samples of adipose tissue from pathological and postmortem examination (Yobs 1971). In FY 1970, a statistical design was implemented based upon 1960 census information. The design called for the collection of 50 adipose samples annually from each of 39 collecting points as shown in Figure 3. An annual quota was established for sex, age, and race according to the national age and sex distribution as shown by the 1960 census information (Yobs 1971).

In 1972, the sampling program was revised to reflect the changes in population trends shown by the 1970 census and to increase the number of sampling sites. Under this revised design, race quotas were reassigned on the basis of local rather than national proportions, fewer specimens are collected from each pathologist in order to allow more pathologists to participate, and a greater geographic spread was obtained for sampling. The number of sampling sites (Figure 4) was increased to 75 with the total number of specimens to be collected set at 2,025 (Kutz and Strassman, personal communication). The current sampling design including sex, age, and race quotas, and the number of sampling sites per census region is shown in Table 7.

Table 8 presents the number of samples collected each year from 1967 to 1972.

Monitoring Residues in Soils

In 1964, the Plant Protection Division, USDA, began monitoring pesticide residue levels in soils (Sand et al 1967). The initial efforts, however, are best referred to as feasibility or pilot studies leading to the current national design. For instance, during the period from 1965-1967, pilot studies were conducted in six study areas and reported on residue levels in soil, water, sediment, and terrestrial and aquatic organisms. Information concerning this effort is given in Table 9. Concurrently, another USDA pilot study was being conducted at 51 nationwide locations as shown in Table 10.

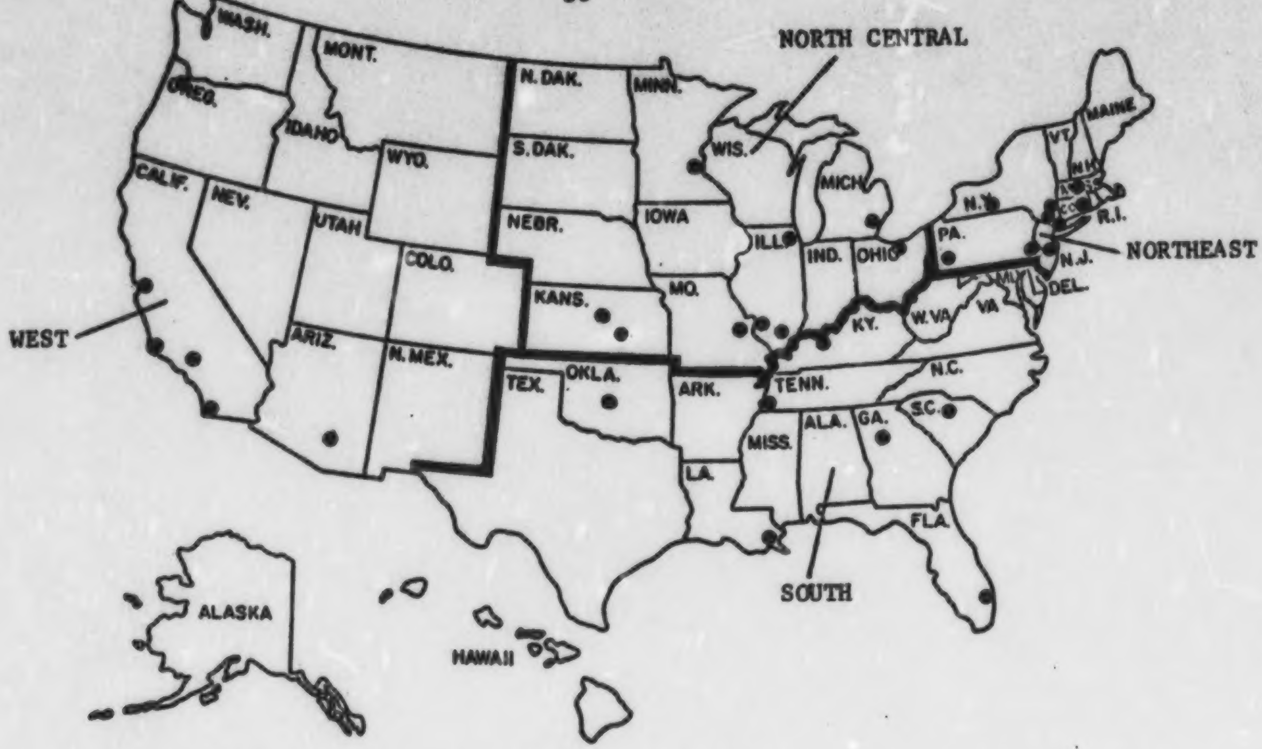
NORTH CENTRAL
WASH.
MONT.
N. DAK.
MINN.
OREG.
IDAHO
S. DAK.
WIS.
MAINE
VT.
NH
WYO.
MICH.
CALIF.
NEV.
UTAH
NEBR.
IOWA
N.Y.
R.I.
CONN.
PA.
ILL.
IND.
OHIO
NORTHEAST
N.J.
COLO.
KANS.
MO.
MD.
DEL.
W.VA.
VA.
KY.
WEST
ARIZ.
N. MEX.
TEX.
OKLA.
ARK.
TENN.
N.C.
S.C.
MISS.
ALA.
GA.
LA.
FLA.
SOUTH
ALASKA
HAWAII

FIGURE 3. MONITORING RESIDUES IN HUMANS--COLLECTION POINTS FOR FY 1970 SAMPLING DESIGN BASED ON CENSUS REGIONS

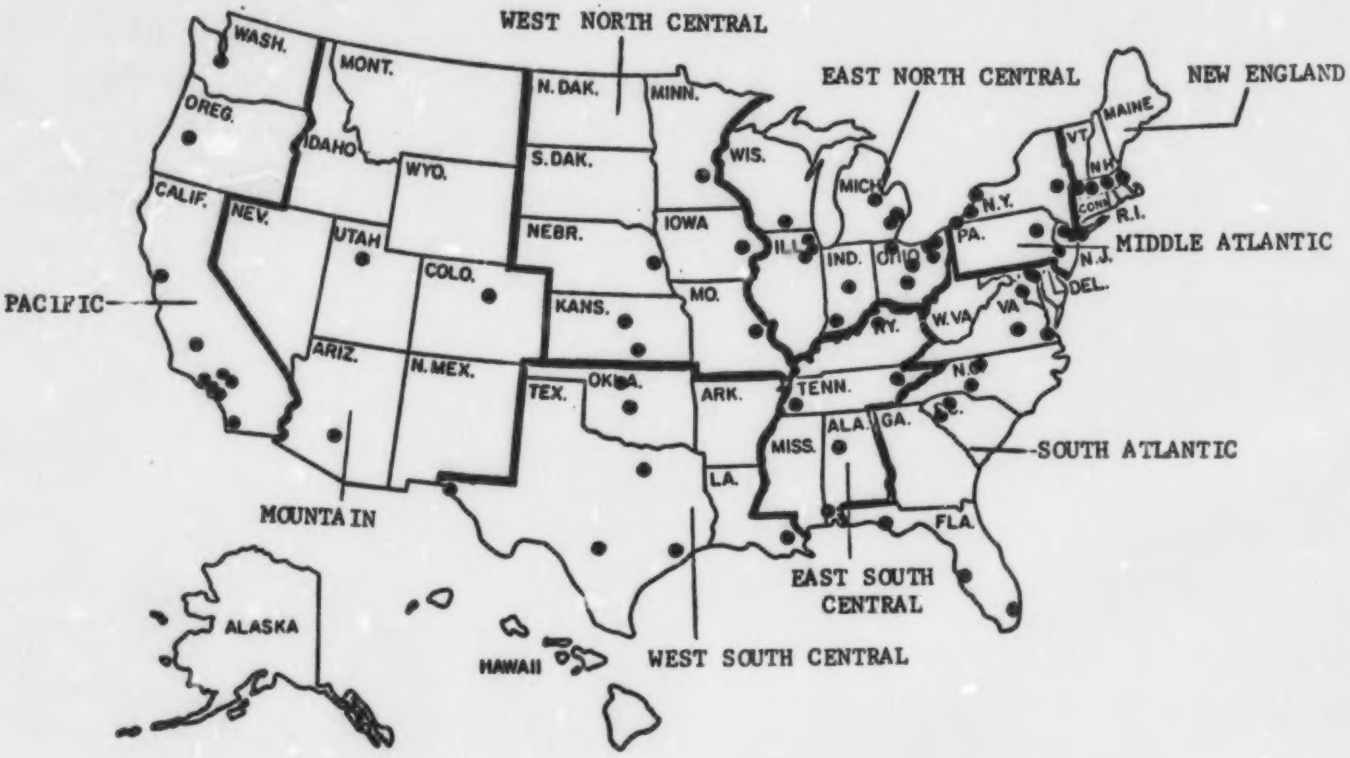
WEST NORTH CENTRAL
EAST NORTH CENTRAL
NEW ENGLAND
WASH.
MONT.
N. DAK.
MINN.
MAINE
OREG.
IDAHO
WYO.
S. DAK.
WIS.
VT.
NH
MICH.
N.Y.
CONN.
CALIF.
NEV.
UTAH
NEBR.
IOWA
R.I.
ILL.
IND.
OHIO
PA.
MIDDLE ATLANTIC
N.J.
PACIFIC
COLO.
KANS.
MO.
DEL.
W.VA.
VA.
KY.
ARIZ.
N. MEX.
TEX.
OKLA.
ARK.
TENN.
N.C.
S.C.
MISS.
ALA.
GA.
SOUTH ATLANTIC
LA.
FLA.
MOUNTAIN
EAST SOUTH CENTRAL
ALASKA
HAWAII
WEST SOUTH CENTRAL

FIGURE 4. MONITORING RESIDUES IN HUMANS--COLLECTION POINTS FOR FY 1972 SAMPLING DESIGN BASED ON CENSUS DIVISIONS

TABLE 7. MONITORING RESIDUES IN HUMANS--SAMPLING DESIGN: FY 1974

		Required Samples Per Site									
	Sample Sites	Age 0-14		15-44		45+		Sub-Totals by Site			
Census Division	Per Region	Male	Female	Male	Female	Male	Female	Male	Female	Blacks[(a)]	Total
New England	4	4	4	5	5	4	5	13	14	1	27
Middle Atlantic	14	4	3	5	6	4	5	13	14	3	27
East North Central	15	4	4	5	6	4	4	13	14	3	27
West North Central	6	4	4	5	5	4	5	13	14	1	27
South Atlantic	11	4	4	5	6	4	4	13	14	6	27
East South Central	5	4	4	5	6	4	4	13	14	5	27
West South Central	7	4	4	6	6	3	4	13	14	4	27
Mountain	3	4	4	6	5	4	4	14	13	1	27
Pacific	10	4	3	6	6	4	4	14	13	2	27
							NATIONWIDE TOTALS	988	1037	239	2025
							PERCENT	48.8	51.2	11.8	

(a) Black samples included in site total, can be male or female in any age class; other samples include Caucasian, Oriential, American Indian, and "other".

Source: Strassman, personal communication (1974).

TABLE 8. MONITORING RESIDUES IN HUMANS--NUMBER AND LOCATION OF SAMPLES TAKEN FROM CY 1967 TO FY 1972

Key: Region
State
City

	CY 1967	CY 1968	CY 1970	FY 1971	FY 1972	FY 1973(g)	FY 1974(g)
No. of Samples Called For By Design	-	-	50	50	40	27	27
New England							
Connecticut							
Bristol	40	70					
Meriden	27	58					
Middletown	32	151					
New Britain	11	150					
Putnam	11	70					
	121	499					
Maine							
Orono			28	100			
Togus				97			
			28	197			
Massachusetts							
Boston	117	230	4		(b)		(c)
Fitchburg (a)			31	51			
Leominster (a)			15	9			
Pittsfield					(b)		(c)
Westfield					(b)		(c)
Worchester					(b)		(c)
	117	230	50	60			
New Hampshire							
Rhode Island							
Vermont							
Middle Atlantic							
New Jersey							
Hoboken					(b)		(c)
Ridgewood (a)			31	23			
			31	23			
New York							
Binghamton (a)			37	137			
Buffalo	1	254			(b)		(c)
Kingston		76					
Jamestown					(b)		(c)
Mineola		188					
New York City (a)			158(c)	194(c)	(b)(d)		(c)(f)
New Rochelle (a)			54	46			
Rochester		77					
Troy					(b)		(c)
	1	595	249	377			
Pennsylvania							
Danville				11			
Erie				36	(b)		(c)
Gettysburg		6					
Hazelton					(b)		(c)
New Castle		168		14			
Philadelphia (a)		81	38	27	(b)		(c)
Pittsburg(a)			22	24			
		255	60	112			
East North Central							
Illinois							
Belleville (a)			25	34			
Chicago (a)	195	240	70(e)	69(e)	(b)(e)		(c)(e)
Evanston			53				
Galesburg			16				
Oak Lawn (a)			70	78			
Oak Park					(b)		(c)
Springfield		21	59	19			
St. Mary's		54		16			
	195	315	293	214			
Indiana							
Evansville		87			(b)		(c)
Franklin		14					
Indianapolis					(b)		(c)
Mishawaka		431	2				
		532	2				(c)
Michigan							
Bay City					(b)		
Detroit (a)			47	66	(b)		(c)
Wyandotte					(b)		(c)
			47	66			
Ohio							
Cincinnati		390	116	143			
Cleveland		309	161	275	(b)		(c)
Columbus			52	78	(b)		(c)
Lima			35	50			
Lorain (a)			61	66			
Mansfield					(b)		(c)
Parma					(b)		(c)
Toledo			8		(b)		(c)
		699	433	617			
Wisconsin							
Beloit					(b)		(c)
Milwaukee		171					
		171					

TABLE 8. (CONTINUED)

	CY 1967	CY 1968	FY 1970	FY 1971	FY 1972	FY 1973	FY 1975
West North Central							
Iowa							
Des Moines (a)				17			
Iowa City					(b)		(c)
				17			
Kansas							
Great Bend			3	29			
Hays			2	7			
Salina(a)			87	45	(b)		(c)
Topeka			13	16			
Witchita (a)			5	7	(b)		(c)
			110	104			
Minnesota							
Duluth		27					
Minneapolis (a)			34				
St. Louis Park					(b)		(c)
		27	34				
Missouri							
St. Joseph				42			
St. Louis (a)		217	17	81	(b)		(c)
		217	17	123			
Nebraska							
Omaha					(b)		(c)
North Dakota							
Bismark			39	3			
			39	3			
South Dakota							
Mitchell			20				
Rapid City		28		23			
Souix Falls (a)	95	186	47	29			
Watertown			10				
	95	214	77	52			
South Atlantic							
Delaware							
Wilmington	49	165					
	49	165					
District of Columbia (a)			21	8	(b)		(c)
			21	8			
Florida							
Hialeah					(b)		(c)
Miami (a)				3			
Miami Beach (a)			92	34			
Panama City					(b)		(c)
Pensacola			18	13			
Tampa					(b)		
			110	50			
Georgia							
Atlanta (a)		189	65	128			
Macon			23	39			
		189	88	167			
Maryland							
Baltimore					(b)		(c)
North Carolina							
Chapel Hill	89	405	59	56			
Charlotte					(b)		(c)
Durham			17	29			
Raleigh		16	97	60			
Winston-Salem					(b)		(c)
	89	421	173	145			
South Carolina							
Anderson					(b)		(c)
Greenville					(b)		(c)
Rock Hill			33				
			33				
Virginia							
Norfolk					(b)		(c)
Petersburg					(b)		(c)
West Virginia							
Huntington							(c)

TABLE 8. (CONTINUED)

	CY 1967	CY 1968	FY 1970	FY 1971	FY 1972	FY 1973	FY 1974
East South Central							
Alabama							
Birmingham			76	25			
Dothian		13					
Mobile					(b)		(c)
Tuscaloosa			17	7	(b)		(c)
		13	93	32			
Kentucky							
Lexington		3	60	70			
Louisville			114	107	(b)		(c)
Owensboro (a)			44	30			
Paducah		5	49	65			
		8	267	272			
Mississippi							
Tupelo				41			
				41			
Tennessee							
Kingsport					(b)		(c)
Memphis (a)	1	373	157	242	(b)		(c)
Nashville		1					
	1	374	157	242			
West South Central							
Arkansas							
Fort Smith			10	7			
Jonesboro			12	17			
Little Rock	20	128	26	55			
	20	128	48	79			
Louisiana							
Lake Charles				10			
Monroe				8			(c)
New Orleans (a)			41	90	(b)		
Shreveport	2	202					
	2	202	41	108			
Oklahoma							
Bartlesville			7				
Chickasha			11	7			(c)
Enid					(b)		
McAlister				58			
Oklahoma City (a)			31	16			(c)
			49	81			
Texas							
Dallas		185			(b)		(c)
El Paso					(b)		(c)
Houston(a)				31	(b)		(c)
Lubbock	11	46					
San Antonio					(b)		(c)
	11	231		31			
Mountain							
Arizona							
Phoenix					(b)		(c)
Tuscon (a)			28	30			
			28	30			
Colorado							
Denver					(b)		(c)
Idaho							
Montana							
Billings			6				
Great Falls			17				
Kalispell			7	7			
			30	7			
Nevada							
Reno		46	2				
		46	2				
New Mexico							
Albuquerque	25	261	1				
Los Alamos				2			
Santa Fe				6			
	25	261	1	8			
Utah							
Salt Lake City					(b)		(c)
Wyoming							

TABLE 8. (CONTINUED)

	CY 1967	CY 1968	FY 1970	FY 1971	FY 1972	FY 1973	FY 1974
Pacific							
Alaska							
California							
Bakersfield					(b)		(c)
Fresno		137					
Glendale					(b)		(c)
Lakewood					(b)		(c)
Loma Linda (a)			42	70			
Long Beach					(b)		(c)
Los Angeles (a)		164	45		(b)(f)		(c)(d)
National City					(b)		(c)
San Diego (a)		461	50	43			
San Francisco		36			(b)		(c)
Stanford (a)			31	50			
		798	168	163			
Hawaii							
Oregon							
Eugene			18	19	(b)		(c)
Grant's Pass				3			
Medford			29				
Ontario			8				
Pendleton			13	1			
Portland (a)			54	12			
			122	35			
Washington							
Tacoma	11	10					(c)
	11	10					
Totals	737	6602	2901	3459			

(a) Original experimental design collection site (FY 1970).
(b) Revised experimental design collection site (FY 1972).
(c) Revised experimental design site (FY 1974)
(d) Samples taken at 2 different hospitals within this city.
(e) Samples taken at 3 different hospitals within this city.
(f) Samples taken at 7 different hospitals within this city.
(g) Data not available.

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[*] Design basis for sample collection has changed over the years as follows:
1967-1968 - No design basis
1970-1972 - Samples were collected on basis of census region
1973-1974 - Samples were collected on basis of census division.

Source: Strassman, personal communication (1974).

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TABLE 9. MONITORING RESIDUES IN SOILS--REPORT ON SOIL, WATER, SEDIMENT AND WILDLIFE IN SIX STUDY AREAS (1965-1967)

Chemical	Environmental Component Showing Chemicals Detected Per Year																	
	Soils(a)			Crops(b)			Water			Sediment			Aquatic Organisms			Terrestrial Organisms		
	1965	1966	1967	1965	1966	1967	1965	1966	1967	1965	1966	1967	1965	1966	1967	1965	1966	1967
DDT	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Dieldrin	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Endrin	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	
TDE	x	x		x			x	x	x	x	x	x	x	x	x	x	x	x
DDE							x	x	x	x	x	x	x	x	x	x	x	x
Toxaphene	(c)	x	x		x													
Lindane		x		x	x		x	x	x									
DEF					x			x										
Methyl Parathion			x		x			x	x									
2,4-D	x		x					x										
BHC																x		
Aldrin	x	x	x	x					x	x							x	
Merphos					x													
Trifluralin	x	x	x				x		x			x			x			
Chlordane	x	x	x				x					x	x	x				x
Ethion														x				
Heptachlor Epoxide					x			x								x	x	x
Heptachlor + its Epoxide	x	x	x							x	x		x					
Endosulfan	x	x	x	x	x		x	x	x									
Ethyl Parathion			x					x	x									
[illegible]		x	x						x									
Combined Parathion		x	x		x	x												
Dicofol				x		x	x	x	x									
Demeton									x									
Disulfoton									x									
Arsenic	x	x	x															

Locations Showing Years Each Component Monitored

	Crystal Springs Mississippi	Greenville Mississippi	Stuttgart Arkansas	Grand Forks North Dakota	Grand Bay Alabama	Yuma Arizona
Soils	1965-66	1965-66	1965-66	1965-67	1965-67	1965-67
Crops	1965-66	1965-66	1965-66	1965-67	1965-67	1965-67
Water	1965-67	1965-67	1965-66	1965-66	1965-67	1965-67
Sediment	1965-67	1965-67	1965-66		1965-67	
Aquatic Organisms	1965-66	1965-66	1965-66	1966	1965-67	1965-67
Terrestrial Organisms	1965-66	1965-66	1965-66	1965-67	1965-67	1965-67

Sampling Frequency by Environmental Component

Soil:
Biannually, before and after pesticide application season

Water:
Contained surface water: 2-week intervals during pest-control season, monthly during the off season
Potable well water: 3-month intervals; immediately before, during, and after the pest control season
Irrigation water: whenever selected blocks were irrigated; sampled as water entered and exited the block
Quick-runoff water: after heavy rainfalls

Sediment:
Random collections

Crops:
Immediately before or at harvest time

Terrestrial Organisms:
Before and after pest control season

Aquatic Organisms:
Fish, turtles, mussels, and crayfish periodically; algae, frogs, tadpoles, and toads whenever possible

(a) Includes soil from paired soil-crop samples
(b) Includes pasture grass
(c) Unreportable due to sulfur interferences

Source: USDA (1969).

TABLE 10. MONITORING RESIDUES IN SOILS—USDA PILOT STUDY AT 51 NATIONWIDE LOCATIONS (1965-1967)

Chemical	Chemicals Detected Per Use Area Per Year				
	Regular Use		Limited Use		No Use
	1965-67	%	1965	1966	1965-1967
DDT	x	100	x	x	x
Dieldrin	x	80		x	
Aldrin	x	5			
Endrin	x	44			
Endosulfan	x	32			
Chlordane	x	36			
Heptachlor Epoxide	x	24			
Toxaphene	x	60			
Trifluralin	x	12			
Arsenic	x	100			

Sampling Locations By Use Area			Sampling Scheme and Frequency by Use Area
Regular Use	Limited Use	No Use	
Lower Rio Grande Valley, Texas Dade County, Florida Eastern S. Carolina Monmouth County, N.J. Kern County, Calif. Western N. Carolina Central Georgia Adams County, Pa. Berrien County, Mich. Yuma County, Arizona Wenatchee, Wisconsin Eastern Virginia Urbana, Illinois Western Iowa Weld County, Colorado Quincy, Washington Tulelake, California	Kalmath County, Oreg. Lincoln County, Idaho Phillips County, Mont. Fremont County, Wyo. Pike County, Kentucky Davy Crockett National Forest, Texas Manistee-Huron National Forest, Michigan Thomas Jefferson National Forest, Virginia Chippiwa National Forest, Minnesota Coconino National Forest, Arizona Lincoln National Forest, New Mexico Stanislavis National Forest, California Chequamegon National Forest, Wisconsin Allegheny National Forest, Pennsylvania Eagle Lake State Forest, Maine Chattahoochee National Forest, Georgia	National Wildlife Refugees: Gulf Islands, Mississippi Kofa, Arizona Okefenokee, Georgia Seney, Michigan Ravalli, Montana Ft. Niobrara, Nebraska San Andres, New Mexico Anahuac, Texas Mississquoi, Vermont Pea Island, N. Carolina National Forests: Pisgah, N. Carolina Oconee, Georgia Francis Marion, S. Carolina Ozark, Arkansas Mark Twain, Missouri Cache, Utah National Grasslands: Cross Timber, Texas Buffalo Gap, S. Dakota	Regular Use: 5 composite samples from each area annually after the pest control season, and a few area samples before the control season. Limited and No Use: 10 composite samples from each area annually in the late summer or fall.

Source: Stevens et al (1970).

In 1967, a six state preliminary study using a new design basis and sampling both cropland and noncropland was initiated (Wiersma et al 1971). Data relative to this program are shown in Table 11.

In FY 1969, the current national soils monitoring program was initiated by USDA (Wiersma et al 1972). The stated objectives of this program are as follows (Wiersma et al 1971):

(1) To determine levels of pesticide residues and major pollutants in soils in major land use areas and other areas in the United States and through periodic sampling, to determine changes in these levels

(2) To determine the levels of pesticide residues in crops grown on treated soil and other components of the environment directly related to the soil

(3) To determine the level of pesticide residues in runoff water of certain agricultural lands

(4) To provide a basis for initiation of special studies on demonstrated problem areas

(5) To publish the results for appropriate distribution.

The experimental design for this program is based upon designating soils as either cropland or noncropland (from Conservation Needs Inventory Design, USDA) and then sampling the soils. In addition, a predetermined number of water, sediment from nearby surface waters, and plant tissue samples are to be taken and analyzed. Also, information relative to cropping and pesticide usage is collected (Wiersma et al 1971). The experimental design is quite ambitious involving sampling one 10-acre block for every 40,000 acres of cropland and one 10-acre block for every 400,000 acres on noncropland sites (Spencer 1974). This amounts to 9,468 cropland sites and 3,832 noncropland sites as shown in Table 12.

The sampling schedule calls for one-fourth of the sites in each state to be sampled each year. On cropland, the samples are taken at harvest; while on noncropland, the samples are collected any time during the year (Wiersma et al 1971).

Responsibility for the program was transferred to EPA in 1970. As presently operated, sample collections are made by the Animal and Plant Health Inspection Service, USDA, under contract to EPA. Sample analyses are

TABLE 11. MONITORING RESIDUES IN SOILS--A PRELIMINARY STUDY IN SIX STATES (1967)

Chemicals	STATES SAMPLED SHOWING PERCENT OF SITES WITH RESIDUE FOR CROPLAND (C) AND NONCROPLAND (NC)													
	Georgia		Idaho		Maine		Nebraska		Virginia		Washington		Total	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
Chlordane	3.3		3.1				8.4		11.8				5.4	
DDE	70	36.8	34.4	10.3	50	25	9.3	5	23.5	14.3	26.7	8.7	25.9	15.4
DDT	66.7	36.8	31.3	10.3	37.5	25	7.5	5	23.5	14.3	15.5	13	21.7	16.2
DDTR[(a)]	70	36.8	34.4	13.8	50	25	10.3	5	35.3	28.6	26.7	13	27.2	18.8
Dieldrin	3.3		18.7				43		17.6		13.3		25.5	
TDE	46.7	10.5	28.1	10.3	37.5	8.3	2.8	5	23.5	14.3	4.4	8.7	14.6	9.4
Toxaphene	33.3		3.1										4.6	
Arsenic	100	100	97	100	100	100	100	100	100	100	100	100	99.6	100
No. Of Samples	30	19	33	29	8	12	107	20	19	14	45	23	242	117

NOTE: blank = not detected

(a) Includes o,p' DDT, p,p' DDT, o,p' TDE, pp' TDE, o,p' DDE, and p,p' DDE

Source: Wiersma et al (1971).

TABLE 12. MONITORING RESIDUES IN SOILS--EXPERIMENTAL DESIGN FOR THE NATIONAL SOILS MONITORING PROGRAM

States Listed by Region	Number of Sampling Sites		
	Cropland (9,468)	Noncropland (3,832)	Total (13,300)
NEW ENGLAND			
Maine	32	48	80
New Hampshire	8	12	20
Vermont	20	12	32
Massachusetts	8	12	20
Rhode Island	4	4	8
Connecticut	8	8	16
Total	80	96	176
MIDDLE ATLANTIC			
New York	152	60	212
New Jersey	20	12	32
Pennsylvania	148	56	204
Total	320	128	448
EAST-NORTH CENTRAL			
Ohio	276	36	312
Indiana	312	28	340
Illinois	568	32	600
Michigan	220	68	288
Wisconsin	272	60	332
Total	1,648	224	1,872
PACIFIC			
Washington	180	92	272
Oregon	152	140	292
California	268	224	492
Total	600	456	1,056
WEST-NORTH CENTRAL			
Minnesota	488	80	568
Iowa	608	28	636
Missouri	328	76	404
North Dakota	636	48	684
South Dakota	424	80	504
Nebraska	428	80	508
Kansas	684	64	748
Total	3,596	456	4,052
SOUTH ATLANTIC			
Delaware	12	4	16
Maryland	52	12	64
Virginia	84	56	140
West Virginia	24	36	60
North Carolina	124	68	192
South Carolina	68	40	108
Georgia	120	80	200
Florida	72	80	152
Total	556	376	932
EAST-SOUTH CENTRAL			
Kentucky	124	52	176
Tennessee	112	56	168
Alabama	92	72	154
Mississippi	124	64	188
Total	452	244	696
WEST-SOUTH CENTRAL			
Arkansas	188	64	252
Louisiana	108	60	168
Oklahoma	260	84	344
Texas	744	344	1,088
Total	1,300	552	1,852
MOUNTAIN			
Montana	340	200	540
Idaho	132	120	252
Wyoming	68	148	216
Colorado	240	140	380
New Mexico	40	192	232
Arizona	36	196	232
Utah	48	128	176
Nevada	12	176	188
Total	916	1,298	2,216

Source: Wiersma et al (1971)

performed by EPA at its National Pesticide Monitoring Laboratory at Bay St. Louis, Mississippi (Spencer 1974). Table 13 indicates the compounds routinely monitored for by the national program. Operational data for the program are shown in Table 14 for fiscal years 1969, 1970, and 1972. Sampling did not occur on a nationwide scale in 1971, due to budgetary constraints (Carey personal communication). Crop monitoring data are available only for FY 1969 and FY 1970. These data are summarized in Tables 15 and 16, respectively.

Sampling for pesticide residues in urban soils was initiated as a pilot study in eight selected sites in FY 1970 as shown in Table 17. The monitoring of urban soils became a regular part of the national program in fiscal year 1971. Sampling presently consists of one analytical sample per square mile in the city proper and one sample per 20 square miles in the suburbs. A sample consists of a composite of 16- 2 x 3 inch cores taken from a 50 x 50 foot plot. As with the cropland soils, personnel from the USDA collect the samples under contract to EPA, and sample analysis is performed by EPA at its Bay St. Louis laboratory (Spencer 1974).

Tables 18, 19, and 20 summarize the available operational information for FY 1971 to FY 1975.

Monitoring Residues in Water

Data relative to pesticides in water have been obtained over the years by a number of government agencies. However, it was not until 1971 that a design for a national program for assessing pesticide residues in water was proposed. The design is a revision of the program begun in 1967 by the Federal Water Pollution Control Administration (FWPCA) (Feltz 1971) but has not yet been fully implemented as an operational element of the NPMP.

The objective of the water monitoring program is to provide a continuing assessment of the general levels of pesticides in the water and bottom sediments of the nation's water courses. The assessment of pesticide levels in the waters of the Great Lakes is not included in the scope of this program (Feltz 1971).

TABLE 13. MONITORING RESIDUES IN SOILS--CHEMICAL COMPOUNDS ROUTINELY MONITORED

Organochlorine Compounds

alachlor
aldrin
benzene hexachloride
captan
chlordane
chlordecone
chlorinated phenoxy esters
chlorobenzilate
DCPA
DDT's (o,p'-DDT; p,p'-DDT; o,p'-DDE; p,p'-DDE; p,p'-TDE)
dicofol
dieldrin
dithianon
DMC
endosulfan I
endosulfan II
endosulfan sulfate
endrin
endrin aldehyde
endrin ketone
heptachlor
heptachlor epoxide
isobenzan
lindane
methoxychlor
mirex
ovex
PCB's
PCNB
propachlor
terpene polychlorinates
toxaphene
trifluralin

Organophosphorous Compounds

azinophosmethyl
carbophenothion
chlerpyrifos
DEF
demeton
diazinon
dioxathion
disulfoton
Dyfonate
EPN
ethion
ethyl parathion
Folex
malathion
methyl demeton
methyl parathion
phorate
ronnel

FY 1969 to date: Arsenic (soil)

Starting FY 1972: Atrazine(a)
Simazine(a)
2,4-D(a)
2,4,5-T(a)

FY 1973 to date: Mercury
(urban areas only) Cadmium
Lead

(a) If applied

Source: Carey, personal communication (1974).

TABLE 14. MONITORING RESIDUES IN SOILS - OPERATIONAL DATA FOR THE NATIONAL SOILS MONITORING PROGRAM (1969-1972)

	Number of Sites Sampled			
	1969	(a)	1970	1972
States Sampled	Cropland	Noncropland	Cropland	Cropland
Alabama	22		21	23
Arizona	8	44		
Arkansas	47		47	46
California	65		65	64
Colorado	60			
Florida	18		17	18
Georgia	22	10	28	30
Idaho	33	26		33
Illinois	142		140	141
Indiana	78		78	58
Iowa	151	7	150	152
Kentucky	31		30	31
Louisiana	27		26	26
Michigan	51		54	55
Mid-Atlantic:			19	18
Maryland	12	3		
Delaware	3			
New Jersey	5			
Minnesota			120	
Mississippi	29		29	31
Missouri	82		81	80
Nebraska	106	19	106	106
New England:			20	20
Connecticut	2			
Maine	8	11		
Massachusetts	2			
New Hampshire	2			
Rhode Island	1			
Vermont	5			
Nevada	2			
New Mexico	10			
New York	38		38	38
North Carolina	31		30	31
North Dakota	157			
Ohio	68		69	57
Oklahoma	64		65	65
Oregon				38
Pennsylvania	29		32	36
South Carolina	17		17	17
South Dakota	106		106	106
Tennessee	27		25	27
Utah	12			
Virginia	21	13	26(b)	27(b)
Washington	45	21		45
West Virginia	6	8		
Wisconsin	67		67	67
Wyoming	17	37		
No. of States Sampled	43	11	35	34
Total No. of Analyses	1729	199	1506	1486

(a) Noncropland category dropped after fiscal year 1969

(b) Virginia and West Virginia

TABLE 15. MONITORING RESIDUES IN SOILS - FY 1969 CROP MONITORING DATA

	STATES																													
CROP CLASS	AL.	AZ.	AR.	CA.	CO.	FL.	GA.	ID.	IL.	IN.	IA.	LA.	ME.	MA.	MD.	MI.	MO.	NE.	NV.	NH.	NJ.	OK.	PA.	SC.	SD.	TN.	VT.	VA.	WA.	WV.
Alfalfa and/or Bur Clover				X						X	X									X								X		X
Barley																													X	
Barley Straw																													X	
Clover								X							X								X							
Corn Stalks	X	X	X	X	X		X		X	X	X	X			X	X	X	X			X	X	X	X	X	X		X		
Cotton Seed	X		X				X					X					X									X				
Cotton Stalks and Green Bolls	X		X				X					X					X									X				
Field Corn	X						X		X	X	X	X			X	X	X	X					X	X	X	X		X		
Grass Hay	X		X	X								X	X	X	X				X	X						X	X	X		
Lespedeza																										X				
Mixed Hay															X											X		X		X
Pasture (never cut for hay)			X																											
Pasture Forage Sample				X																								X		
Rice			X																											
Sorghum									X																					
Sorghum Stalks		X			X																					X				
Soybeans			X				X		X	X	X	X					X	X								X		X		
Soybean Hay																										X				
Tangelos						X																								
Temporary Pasture				X																										
Turf (grass and/or legume)					X																									
Wheat								X																						X
Wheat Straw								X																						X

TABLE 16. MONITORING RESIDUES IN SOILS--FY 1970
CROP MONITORING DATA

FY 1970 CROP MONITORING

Crop Class	No. of Sites Analyzed by Chemical Class Chlorinated Hydrocarbons	Orhanophosphates
Alfalfa and/or Bur Clover	39	37
Cotton (stalks and green bolls)	33	18
Cotton (seeds)	39	37
Field Corn (kernels)	276	240
Field Corn (stalks)	270	228
Grass Hay	48	47
Mixed Hay	29	29
Soybeans (beans)	178	137

Source: Crockett et al.

TABLE 17. MONITORING RESIDUES IN SOILS--FY 1970 URBAN AREA STUDY

Sample Site	Total Number of Samples
Bakersfield, California	50
Camden, New Jersey	50
Houston, Texas	50
Manhatten, Kansas	50
Miami, Florida	50
Milwaukee, Wisconsin	49
Salt Lake City, Utah	50
Waterbury, Connecticut	50

Source: Carey, personal communication (1974).

TABLE 18. MONITORING RESIDUES IN SOILS--FY 1971 URBAN AREA STUDY

Sample Site	No. of Lawn Area Samples	No. of Waste Area Samples	Total No. of Samples
Augusta, Maine	2	25	27
Charleston, South Carolina	11	16	27
Cheyenne, Wyoming	7	12	19
Grand Rapids, Michigan	12	11	23
Greenville, Mississippi	20	8	28
Honolulu, Hawaii	18	3	21
Memphis, Tennessee	13	15	28
Mobile, Alabama	(a)	(a)	29
Philadelphia, Pennsylvania	15	11	26
Portland, Oregon	10	15	25
Richmond, Virginia	17	10	27
Sikeston, Missouri	17	10	27
Sioux City, Iowa	15	7	22
Wilmington, Delaware	10	17	27

(a) Information not available.

Source: Carey, personal communication (1974).

TABLE 19. MONITORING RESIDUES IN SOILS--FY 1972 URBAN AREA STUDY

Sample	No. of Lawn Area Samples	No. of Waste Area Samples	No. of Urban Area Samples	No. of Suburban Area Samples	Total No. of Samples
Baltimore, Maryland	54	102	74	82	156
Gadsden, Alabama	22	33	30	25	55
Hartford, Connecticut	22	26	16	32	48
Macon, Georgia	15	28	13	30	43
Newport News, Virginia	32	46	68	10	78

Source: Carey, personal communication (1974).

TABLE 20. MONITORING RESIDUES IN SOILS--FY 1973, 1974, AND 1975 URBAN AREA MONITORING

Urban Area		
FY 1973	FY 1974	FY 1975
Des Moines, Iowa	Evansville, Indiana	San Francisco, California
Fitchburg, Massachusetts	Greenville, South Carolina	Pine Bluff, Arkansas
Lake Charles, Louisiana	Pittsfield, Massachusetts	Gary, Indiana
Pittsburgh, Pennsylvania	Tacoma, Washington	Durham, North Carolina
Reading, Pennsylvania	Washington, D. C.	Springfield, Illinois

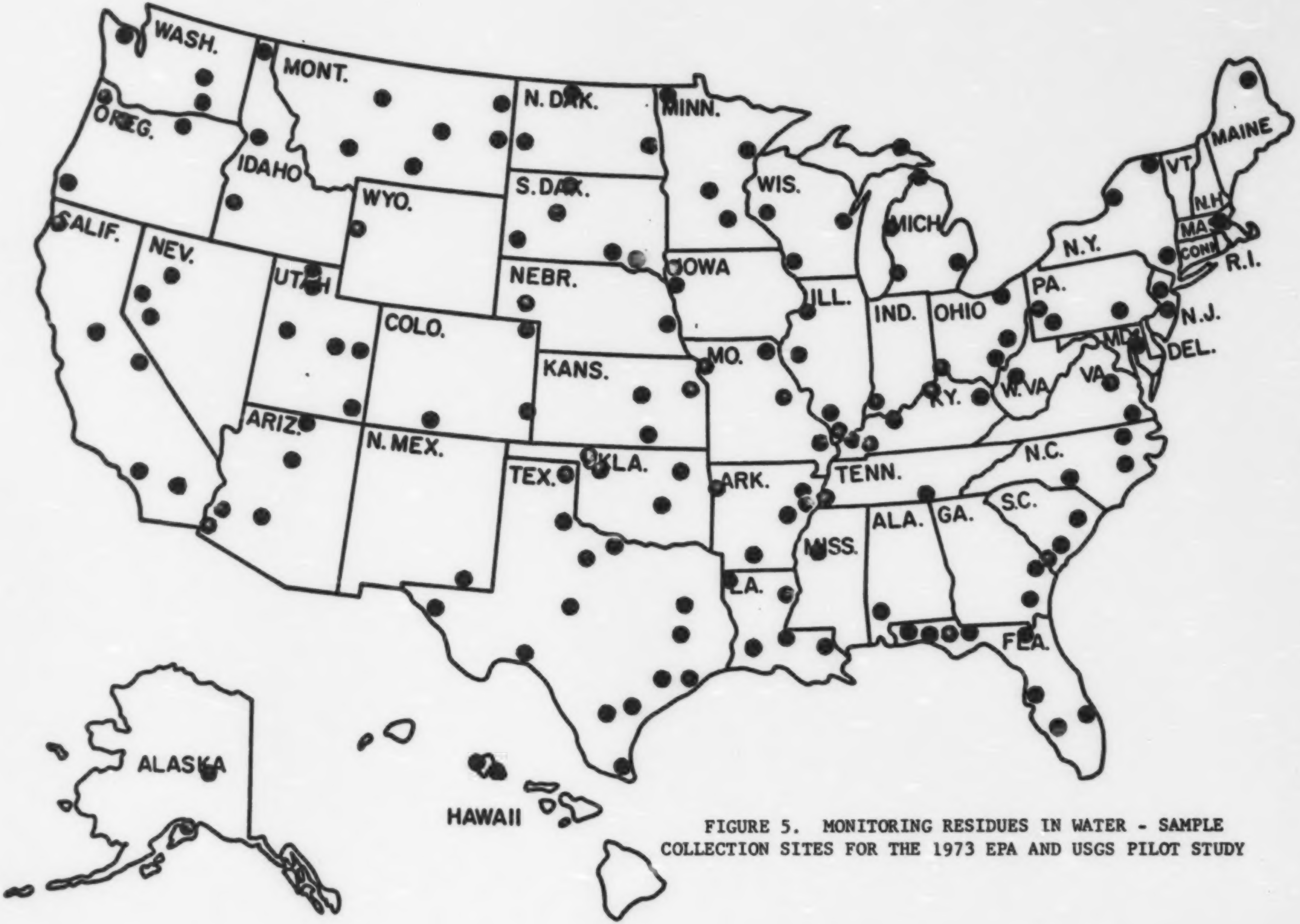
Source: Carey, personal communication (1974).

In 1973, the proposed program was expanded to represent a joint venture between the United States Geological Survey (USGS) and the EPA. Under this revised program, water samples are to be collected four times a year (winter, spring, summer, and fall) and bottom sediment samples are to be collected twice a year (spring and fall). The samples are to be collected by the USGS and then analyzed for pesticide content by EPA's Bay St. Louis Pesticide Monitoring Laboratory (Feltz and Manigold, personal communication). Water and bottom sediment samples will be taken at the 153 locations shown in Figure 5 and listed in Table 21. These sampling sites are generally compatible with the odd numbered USGS National Water Data Network sites. The program was tested, in 1973, as a pilot study to work out problems associated with sampling and analytical methodologies. The first data expected to be available from this program will result from collections initiated in FY 1975 (Feltz and Manigold, personal communication).

As mentioned above, numerous other programs have been conducted to monitor pesticide residues in water. For instance, in 1967 the Public Health Service reported on the levels of chlorinated hydrocarbon pesticides in major river basins covering the period from 1957 to 1965 (Breidenbach et al, 1967). Lichtenberg (1970) reported the results of annual FWPCA synoptic surveys for chlorinated hydrocarbons in United States surface waters for the period 1964 to 1968 (Tables 22 and 23). The USGS has surveyed pesticide residue levels in selected western streams from 1968 to the present (Schulze 1973; Manigold personal communication). While these studies are not part of the NPMP, they have helped to develop the methodologies which will be employed by the national program.

Monitoring Residues in Wildlife

Monitoring residue levels in wildlife is accomplished by five programs which are administered by both the Environmental Protection Agency and the Bureau of Sport Fisheries and Wildlife, USDI as shown in the following tabululation:


WASH.
MONT.
N. DAK.
MINN.
MAINE
OREG.
IDAHO
S. DAK.
WIS.
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CONN
R.I.
N.Y.
WYO.
CALIF.
NEV.
UTAH
NEBR.
IOWA
PA.
N.J.
ILL.
IND.
OHIO
COLO.
MD.
DEL.
KANS.
MO.
VA.
W. VA
KY.
ARIZ.
N. MEX.
OKLA.
TEX.
ARK.
TENN.
N.C.
S.C.
ALA.
GA.
MISS.
LA.
FLA.
ALASKA
HAWAII

FIGURE 5. MONITORING RESIDUES IN WATER - SAMPLE COLLECTION SITES FOR THE 1973 EPA AND USGS PILOT STUDY

TABLE 21. MONITORING RESIDUES IN WATER--SAMPLE LOCATIONS AS OF 1973

State	River	Location
Alabama	Tombigbee	Near Jackson
Alaska	Tanana	At Nenana
	Kenai	Near Cooper Landing
Arizona	Colorado	At Lees Ferry
	Little Colorado	Near Cameron
	Gila	Above Div at Gillespie Dam
	Bill Williams	Below Mineral Wash Near Planet
	Colorado	At North International Boundary
Arkansas	Mississippi	At Memphis, Tennessee
	St. Francis	Near Parkin
	Ouachita	Below Camden
	White	At Claredon
	Arkansas	At Dam Near Van Buren
California	Klamath	Near Klamath
	Sacramento	At Freeport
	Salinas	Near Spreckles
	Santa Ana	Below Prado Dam
	Owens	Near Big Pine
Colorado	South Platte	At Julesburg
	Arkansas	Near Coolidge
	Rio Grande	Near Lobatos
Florida	St. Mary's	Near MacClenny
	Main Canal	At Vero Beach
	Peace	At Arcadia
	Hillsborough	Near Zephyrhills
	Ochlockonee	Near Havana
	Chipola	Near Altha
	Choctawhatchee	Near Bruce
	Yellow	At Milligan
Georgia	Altamaha	At Doctortown
Hawaii	Waikele Stream	At Waipahu
	Kalihi Stream	At Kalihi
Idaho	Kootenai	Near Copeland
	Snake	Near Murphy
	Salmon	At White Bird
Illinois	Rock	Near Joslin
	Illinois	At Meredosia
	Big Muddy	At Murphysboro
Indiana	White	Near Hazelton
Iowa	Missouri	At Sioux City
Kansas	Smoky Hill	At Enterprise
	Kansas	At Desoto
	Arkansas	At Arkansas City
Kentucky	Big Sandy	At Louisa
	Ohio	At Markland Dam
	Licking	At McKinneysburg
	Ohio	At Owensboro
	Cumberland	Near Grand Rivers
	Ohio	At L&D Near Grand Chain, Illinois
Louisiana	Boque Chitto	Near Bush
	Tensas	At Tendal
	Mississippi	Near St. Francisville
	Calcasieu	Near Kinder
	Red	Near Hosston
Maine	Aroostook	At Washburn
Maryland	Choptank	Near Greensboro
Massachusetts	Merrimack	Above Lowell
Michigan	Tahquamenon	Near Tahquamenon Paradise
	Kalamazoo	At Saugatuck
	Manistee	At Manistee
	Cheboygan	At Cheboygan
	Clinton	At Mt. Clemens
Minnesota	St. Louis	At Scanlon
	Minnesota	Near Jordan
	Mississippi	Near Royalton
	Roseau	Near Caribou
Mississippi	Yazoo	At Greenwood
	Des Moines	At St. Francisville
	Mississippi	At Thebes
	Missouri	At St Joseph
	Missouri	At Hermann

TABLE 21. (CONTINUED)

State	River	Location
Montana	Missouri	At Toston
	Missouri	At Virgelle
	Musselshell	At Mosby
	Missouri	Near Culberton
	Yellowstone	At Billings
	Yellowstone	Near Sidney
Nebraska	North Platte	At Lisco
	Platte	Near Louisville
Nevada	Humboldt	Near Rye Patch
	Truckee	Near Nixon
	Walker	Near Wabuska
New Jersey	Raritan	Near Bound Brook
	Delaware	At Trenton
New Mexico	Pecos	At Red Bluff
New York	Richelieu	At Rouses Point
	Hudson	Near Poughkeepsie
	Black	At Watertown
North Carolina	Roanoke	Near Scotland Neck
	Neuse	At Kingston
	Pee Dee	Near Rockingham
North Dakota	Souris	Near Westhope
	Red River of the North	At Oslo
	Little Missouri	Near Watford
Ohio	Cuyahoga	At Independence
	Muskingum	At McConnelsville
	Hocking	Below Athens
	Great Miami	At Elizabethtown
Oklahoma	Cimarron	Near Buffalo
	Newt Graham L&D	Near Inola
	North Canadian	At Woodward
	Canadian	At Calvin
Oregon	John Day	At McDonald Ferry
	Tualatin	At West Linn
	Nehalem	Near Ross
	Rogue	Near Agness
Pennsylvania	Susquehanna	At Harrisburg
	Allegheny	At Oakmont
	Beaver	At Beaver Falls
Puerto Rico	Rio Grande De Manati	Near Manati
	Rio Grande De Anasco	Near San Sebastian
	Rio Grande De Patillas	Near Patillas
South Carolina	Black	At Kingstree
	Edisto	Near Givhans
	Savannah	Near Clyo
South Dakota	Cheyenne	At Cherry Creek
	Grand	At Little Eagle
	White	Near Oacoma
	James	Near Scotland
	Big Souix	At Akron
Tennessee	Tennessee	At South Pittsburg
Texas	Canadian	Near Canadian
	Prairie Dog Town Fork	Near Childress
	Red	Near Burkburnett
	Sabine	Near Ruliff
	Trinity	Near Crockett
	West Fork San Jacinto	Near Conroe
	Brazos	At Seymour
	Brazos	Near Rosharon
	Colorado	At Ballinger
	Colorado	At Wharton
	San Antonio	At Goliad
	Nueces	Near Three Rivers
	Rio Grande	At Fort Quitman
	Rio Grande	At Foster Ranch
	Pecos	Near Langtry
	Rio Grande	At Brownsville
Utah	Green	At Green River
	Colorado	Near Cisco
	San Juan	Near Bluff
	Bear	Near Corinne
	Weber	Near Plain City
	Sevier	Near Lynndyl
Virginia	Pamunkey	Near Hanover
	Blackwater	Near Franklin
Washington	Spokane	At Long Lake
	Yakima	At Kiona
	Elwha	At McDonald Bridge Near Port Angeles
West Virginia	Kanawha	At Winfield
Wisconsin	Fox	At Wrightsontown
	Chippewa	At Durano
Wisconsin	Wisconsin	At Bridgeport
Wyoming	Snake	Above Reservoir Near Alpine

Source: Crockett, personal communication (1974).

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TABLE 22. SAMPLING LOCATIONS FOR FWPCA SURVEYS OF PESTICIDES IN UNITED STATES SURFACE WATERS: 1964-1968

Sample Locations By Region								
Northeast	Middle Atlantic	Southeast	Ohio Basin	Great Lakes Basin	Missouri Basin	South Central	Southwest	Northwest
Connecticut River Enfield Dam, Connecticut Northfield Massachusetts Wilder, Vermont Schuylkill River Philadelphia, Pennsylvania Hudson River Poughkeepsie, New York Narrows, New York Merrimack River Lowell, Massachusetts Delaware River Trenton, New Jersey Martins Creek, Pennsylvania Raritan River Perth Amboy, New Jersey Delaware Bay	Potomac River Great Falls, Maryland Washington, D.C. Shenandoah River Berryville, Virginia Susquehanna River Conowingo, Maryland Sayre, Pennsylvania Roanoke River John H. Kerr Dam, Virginia Neuse River Raleigh, N. Carolina	Apalachicola River Chattahoochee, Florida Beauclair River Lake Apopka, Florida Escambia River Century, Florida Oklawaha River Orlando, Florida W. Palm Beach Canal W. Palm Beach, Florida Chattahoochee River Lanett, Alabama Savannah River Port Wentworth, Georgia North Augusta, South Carolina Clinch River Kingston, Tennessee Tennessee River Bridgeport, Alabama Lenoir City, Tennessee Tombigbee River Columbus, Mississippi	Allegheny River Pittsburgh, Pennsylvania Kanawha River Winfield Dam, W. Virginia Monongahela River Pittsburgh, Pennsylvania Ohio River Cairo, Illinois Evansville, Indiana Cincinnati, Ohio Above Addison, Ohio Wabash River Lafayette, Indiana New Harmony, Indiana	St. Lawrence River Massena, New York Lake Erie Buffalo, New York Detroit River Detroit, Michigan St. Clair River Port Huron, Michigan St. Mary's River Sault Ste. Marie, Michigan Saginaw River Bay City, Michigan Lake Superior Duluth, Michigan Lake Michigan Milwaukee, Wisconsin Maumee River Toledo, Ohio Illinois River Peoria, Illinois Mississippi River Cape Girardeau, Missouri E. St. Louis, Illinois Burlington, Iowa Dubuque, Iowa St. Paul, Minnesota Fox River Green Bay, Wisconsin	Missouri River St. Louis, Missouri Kansas City, Kansas Omaha, Nebraska Yankton, S. Dakota Bismarck, N. Dakota North Platte River Henry, Nebraska Platte River Plattsmouth, Nebraska South Platte River Julesburg, Colorado Yellowstone River Sidney, Montana Rainy River Baudette, Minnesota Red River (North) Grand Forks, N. Dakota Emerson, Manitoba Kansas River Lawrence, Kansas Big Horn River Hardin, Montana	Atchafalaya River Morgan City, Louisiana Arkansas River Pendleton Ferry, Arkansas Fort Smith, Arkansas Ponca City, Oklahoma Coolidge, Kansas Brazos River Arcola, Texas Mississippi River New Orleans, Louisiana Vicksburg, Mississippi Delta, Louisiana West Memphis, Arkansas New Roads, Louisiana Red River (South) Alexandria, Louisiana Denison, Texas Rio Grande River Brownsville, Texas El Paso, Texas Alamosa, Colorado Verdigris River Nowata, Oklahoma Trinity River Houston, Texas	Bear River Preston, Idaho Colorado River Yuma, Arizona Parker Dam, California Boulder City, Nevada Page, Arizona Green River Dutch John, Utah Klamath River Keno, Oregon Sacramento River Greens Landing, Calif. San Joaquin River Vernalis, California San Juan River Shiprock, New Mexico Truckee River Farad, California	Clearwater River Lewiston, Idaho Columbia River Clatskanie, Oregon Bonneville Dam, Oregon McNary Dam, Oregon Pasco, Washington Pend Oreille River Albeni Falls, Idaho Snake River Wawawai, Washington American Falls, Idaho Spokane River Post Falls, Idaho Willamette River Portland, Oregon Yakima River Richland, Washington

Source: Lichtenberg at al (1970).

TABLE 23. SUMMARY OF PESTICIDE OCCURRENCES IN UNITED STATES SURFACE WATERS--FWPCA SURVEYS: 1964-1968

Chemical	Pesticide Occurrences By FWQA Region 1964-1968 With 1967 And 1968 Results Reported Separately																										
	Northeast			Middle Atlantic			Southeast			Ohio Basin			Great Lakes Basin			Missouri Basin			South Central			Southwest			Northwest			Total		
	1964-68	1967	1968	1964-68	1967	1968	1964-68	1967	1968	1964-68	1967	1968	1964-68	1967	1968	1964-68	1967	1968	1964-68	1967	1968	1964-68	1967	1968	1964-68	1967	1968	1964-68	1967	1968
Dieldrin	31	6	7	14	1	3	28	4	6	20	2	4	22	4	4	25	4	3	34	3	3	13			12	1	2	199	25	29
Endrin	4			4			9			2			7	1		13	1		19			5			4			67	2	
DDT	6	1	2	4		1	10	1	2	9		1	2			18	2	3	18	2	3	10		1	9		2	86	6	15
DDE	2			1			3	1	1	1			4			6			4	1		5			3			29	2	1
DDD	10	1		6			10	4	1	4			10	1		10	1		10	2		4			4			68	9	1
Aldrin																			1			1						2		
Heptachlor	1						1			2			3			4			3			2						16		
Heptachlor Epoxide	2			2			3			3			7			6			3			2			1			29		
Lindane	2	2					2	3			1		1	1		2	1	1	3	3	1							10	11	2
BHC	2			2	1	1	3		2	12	3	4	4	3		3		1	7		3	2						35	7	11
Chlordane				1			3															1						5		
Total	60	10	9	34	2	5	72	13	12	53	6	9	60	10	4	87	9	8	102	11	10	45	0	1	33	1	4	546	62	59
Number of Samples	53	(a)	(a)	32	(a)	(a)	50	(a)	(a)	41	(a)	(a)	76	(a)	(a)	70	(a)	(a)	86	(a)	(a)	65	(a)	(a)	56	(a)	(a)	529	110	114

(a) Sample size not available

Total Number of Chlorinated Pesticide Occurrences By Year

Year	Number of Samples Collected	Number of Samples With Positive Occurrences	Total Number Of Positive Occurrences
1964	97	73	130
1965	99	56	120
1966	109	80	177
1967	110	34	56
1968	114	48	63
Total	529	291	546

Source: Lichtenberg et al (1970).

Subprogram	Sponsoring Agency
Bald and Golden Eagles	Bureau of Sport Fisheries and Wildlife
Estuarine Finfish and Shellfish	Environmental Protection Agency
Fish from Lakes and Rivers	Bureau of Sport Fisheries and Wildlife
Mallard and Black Ducks	Bureau of Sport Fisheries and Wildlife
Starlings	Bureau of Sport Fisheries and Wildlife

The objective of the wildlife program is to ascertain, on a nationwide basis and independent of specific treatments, the levels and trends of certain pesticidal chemicals and other pollutants in the bodies of selected forms of wildlife. Criteria used to determine species selection are: (1) forms should be geographically well distributed, (2) forms should be reasonably abundant, (3) forms should be readily available for sampling, and (4) forms should occur near the top of a food chain (Dustman et al 1971).

For clarity, each program is discussed separately.

Bald and Golden Eagles

In 1960, evidence was found that indicated the presence of pesticide residues in bald eagles. Subsequently, in 1964, the BSFW decided to include the eagle in the National Wildlife Pesticide Monitoring Program. This decision was based on the fact that eagles represent a top carnivore in food chains. It was concluded that pesticide residue levels in eagles would reflect contamination of organisms used by the eagle for food (Reichel et al 1969).

The bald eagle subprogram is based on circumstance rather than a planned experimental design. Eagles are protected by law and are not available in numbers sufficient for statistical sampling. Thus, although this program is included as part of the NPMP, it is not a monitoring program in the true sense of the word.

Since a systematic sampling scheme could not be considered for bald eagles, samples are obtained from Federal, state, and private individuals who find dead or dying eagles. The bodies are wrapped, packed in dry ice, and sent to the Patuxent Wildlife Research Center for residue analysis. Data relative to the chemicals monitored and the number and distribution of samples for this program are given in Table 24.

TABLE 24. MONITORING RESIDUES IN WILDLIFE--SUMMARY OF DATA RELATIVE TO BALD AND GOLDEN EAGLES

	Year[(a)] and Type of Eagle								
	1964		1965		1966	1967	1968	1969	1970
Chemical	Bald	Golden	Bald	Golden	Bald	Bald	Bald	Bald	Bald
DDT and Metabolites[(b)]	x	x	x	x	x	x	x	x	x
Endrin	x		x						
Heptachlor Epoxide	x	x	x	x	x	x	x	x	x
PCB								x	x
Mercury								x	x
Number of Samples[(c)]	16	5	29	16	21	22	26	28	11
Distribution of Samples by Site									
Alabama	1								
Alaska			2		1	2			
Arizona			1						
Arkansas					1				
California			1	2					
Connecticut						1			
Florida			1		1		2		1
Idaho							1		
Illinois							2	2	1
Indiana	3		1						
Iowa	1		2		4	2	1	1	
Maine.						1		1	
Maryland							2		1
Massachusetts	1				1		1		
Michigan	1				4	3	1	4	3
Minnesota	3	1	2		2	5	3	6	1
Missouri	1				1		2	5	
Montana					1				
Nebraska		1	3	2					
New Jersey							1		
New York						1			
North Dakota			1					3	
Ohio	1				1			2	
Oregon			1			1			
South Carolina						1	1		1
South Dakota	1	3	3	12			2		
Tennessee						1			
Utah							2		
Vermont	1								
Virginia									1
West Virginia						1			
Wisconsin	2		9		4	3	4	4	2
Wyoming							1		
Quebec			1						
Nova Scotia			1						
Number of Locations	11	3	14	3	11	12	15	9	8

(a) Data are reported on a 12 month basis for dead or moribund eagles found that year

(b) Includes p,p' DDE; p,p' DDD; p,p' DDT; and Dichlorobenzophenone (DCBP)

(c) One bird equals one sample

Source: Reichel et al (1969); Mulhern et al (1970); Belisle et al (1972).

Estuaries

Concerned with the question of pesticide transport to estuaries from polluted waterways, the Bureau of Commercial Fisheries designed, in 1965, a program to monitor the incidence of chlorinated hydrocarbons in selected estuaries of the United States (Johnson et al 1967). At this time, available data suggested that the mollusk would be a suitable indicator species. From 1965 through 1972, duplicate samples of 15 or more mature mollusks were collected monthly for laboratory analyses (Butler 1973). Table 25 summarizes the estuarine monitoring program with regard to mollusks. As can be seen, some 8,095 samples were analyzed for chlorinated hydrocarbons between 1965 and 1972. A compilation of sample locations, sepcies sampled, and number of positive detections is given in Table 26 along with the numbers of samples taken at each location. Figure 6 shows the approximate locations of the estuaries from which mollusk specimens were collected for analysis. However, further studies (Lowe et al 1971) revealed that mollusk residue levels reflect ambient pesticide concentrations; thus, even though it is an excellent indicator for seasonal pesticide fluctuations, it is not a suitable species for evaluating long-term trends.

In July, 1972, EPA's Ecological Monitoring Branch assumed responsibility for the estuarine program. At this time, a new experimental design was developed. The objectives of the estuarine fishes program are to systematically collect and analyze samples of estuarine biota and physical substrates for levels of contamination by specified toxicants (Butler 1972).

To satisfy these objectives, a stratified sampling scheme has been developed:

(1) Two samples of 25 whole fishes, not more than one year old of both an herbivorous and a carnivorous species will be collected from selected estuaries at 6-month intervals. If pesticide residues in fishes are more than 1.0 ppm, Stage II would be initiated.

(2) Stage II calls for the collection of two samples of 15 mature oysters in mid-summer and a continuation of fish sampling. If pesticide residues in mollusks are more than 0.5 ppm, Stage III would be initiated.

(3) Stage III calls for the collection of plankton, bottom sediments, fishes, and mollusks to determine whether residues are concentrated at specific sites or trophic levels.

TABLE 25. MONITORING RESIDUES IN WILDLIFE--SUMMARY OF ESTUARIES DATA RELATIVE TO MONITORING OF SHELLFISH (1965-1972)

State	Percent of Samples Positive for Indicated Compound							Number of Sample Collections by Year (a)								
	DDT	Dieldrin	Endrin	Toxaphene	Mirex	PCB's		1965	1966	1967	1968	1969	1970	1971	1972	Totals
Alabama	100	18									13	20				33
California	92	25	2	1		3			136	180	167	139	45	75	30	772
Delaware	75	13							16	101	99	71				287
Florida	62	7				7		6	80	102	82	44	35	19	6	374
Georgia	15	21		19		2				112	127	124	121	120	60	664
Maine	18	4						6	95	89	79	53	44			366
Maryland	81	13							18	20	26	9	15			88
Mississippi	61	4						30	71	72	72	63	66	60	36	470
New Jersey	100	24				3			23	44	45	39	33	27	8	219
New York	81	43							148	183	175	174	148	143	88	1059
North Carolina	75	1							96	201	204	204	124	136	66	1031
South Carolina	54	4			2			72	142	143	145	108				610
Texas	73	18	3			1		53	133	125	93	97	103	95	29	728
Virginia	87	17				3		56	117	123	120	112	105	27	9	669
Washington	11	1						40	218	223	214					695
							Total	263	1293	1718	1661	1287	839	702	332	8095

Note: Blanks represent zeros

(a) Each sample represents 15 or more mature mollusks taken monthly

Source: Butler (1973).

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TABLE 26. MONITORING RESIDUES IN WILDLIFE--SUMMARY OF ESTUARINE DATA RELATIVE TO SAMPLE LOCATION, NUMBER OF SAMPLES, AND SPECIES OF SHELLFISH MONITORED

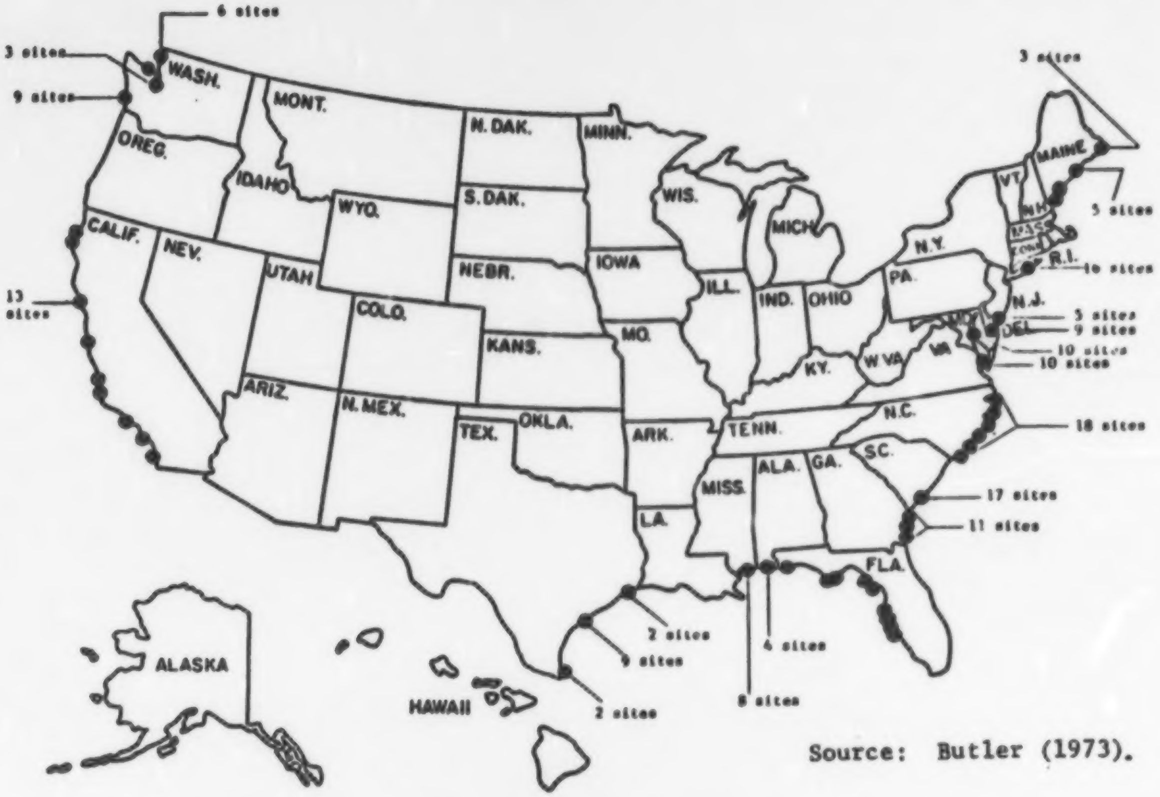
State	Location	Monitoring Period (a)	Principle Species Monitored	Number of Samples (b)	Number of Positive Samples						Total Number of Samples
					DDT	Dieldrin	Endrin	Toxaphene	Mirex	PCB's	
Alabama	Shellbank	1968-69	C. virginica	8	8	1					33
	Klondike	1968-69	C. virginica	8	8	1					
	White House	1968-69	C. virginica	7	7	2					
	Cedar Point	1968-69	C. virginica	8	8	2					
	Occasional stations(2)	1968-69	C. virginica	2	2						
California	Redondo Lagoon	1967-72	M. edulis	31	31	4		2		2	772
	Anaheim Slough	1967-72	M. edulis	33	33	10	1			2	
	Point Mugu	1967-72	M. edulis	39	29	9	1			2	
	Baywood Park	1966-72	C. gigas	52	52	3					
	Los Osos Creek	1966-72	C. gigas	52	52	4				1	
	Elkhorn Slough	1966-72	C. gigas	57	57	24	2			2	
	Coyote Point	1966-72	O. lurida	55	54	26	2			1	
	Guadalupe Slough	1968-72	M. demissus	27	25	9				1	
	Alviso Slough	1968-72	M. demissus	28	28	6				1	
	West Island	1967-72	C. fluminea	28	28	27	3			1	
	False River	1967-71	C. fluminea	26	26	12	1				
	Napa River	1968-72	M. demissus	28	26	5	2			1	
	Petaluma River	1968-72	M. demissus	28	25	4				1	
	Point San Quencin	1966-70	C. gigas	50	49	22					
	Bolinas Lagoon	1966-68	C. gigas	17	16						
	Schooner Bay	1966-72	C. gigas	33	25	2				1	
	Berries Bar	1966-68	C. gigas	27	25		1				
	Tomales Bay	1966-72	C. gigas	34	28	2	1				
	Hicks Cove	1966-68	C. gigas	25	20						
	Gunther Island	1966-72	C. gigas	33	31	5					
	Bird Island	1966-68	C. gigas	25	3					1	
	Occasional stations(2)	1966-72	Mixed	54	51	25		2		6	
Delaware	Leipsic River	1967-69	M. demissus	27	23	4					387
	Simons River	1967-69	M. demissus	25	23	6					
	Bowers Beach	1966-69	C. virginica	34	34	25					
	Mispillion River	1966-69	C. virginica	35	33	2					
	Broadkill River	1966-69	C. virginica	34	34						
	Cape Henlopen	1966-69	M. mercenaria	32	30						
	Thompson Island	1966-69	M. mercenaria	33	3						
	Arrowhead Point	1966-69	M. mercenaria	34	4						
	West Gables	1966-69	M. demissus	33	30						
Florida	Iona Point	1967-69	C. virginica	31	31	1					376
	Charlotte Harbor	1966-69	C. virginica	31	[illegible]	13					
	Coral Cove	1966-69	C. virginica	32	32						
	Manatee River	1966-69	C. virginica	32	32						
	Crystal River	1966-71	C. virginica	43	7						
	Suwanee River	1966-69	C. virginica	32	6						
	St. Vincents Bar(North)	1966-67	C. virginica	17	12	3					
	St. Vincents Bar(South)	1966-67	C. virginica	16	10	3					
	East Bay	1965-72	C. virginica	84	46					25	
	Occasional stations(21)	1966-71	C. virginica	56	26	7					
Georgia	Larretta Creek	1967-72	C. virginica	64	30	58					666
	Wilmington River	1967-72	C. virginica	65	21	27					
	Ogecchee River	1967-72	C. virginica	65	13	15				1	
	St. Catherine Sound	1967-72	C. virginica	65	7	2				1	
	Sapelo Sound	1967-72	C. virginica	65	12	6				2	
	Doboy Sound	1967-72	C. virginica	64	7	8				1	
	Egg Island	1967-72	C. virginica	65	3	22					
	St. Simons Sound	1967-72	C. virginica	65		3		64		2	
	Terry Creek	1967-70	C. virginica	16				16			
	Jekyll Island	1967-72	C. virginica	62				37		8	
	Satilla River	1967-72	C. virginica	64	3			8		1	
	Occasional stations(2)	1968-69	C. virginica	4				3			
Maine	Mill Cove	1965-66	M. arenaria	12							396
	Machiasport	1965-70	M. arenaria	52	2						
	Millbridge	1966-70	M. arenaria	37	1						
	Fort Point	1965-70	M. arenaria	42	1						
	Thomaston	1965-70	M. arenaria	42	1	1					
	Medomak	1967-70	M. arenaria	23	2						
	Small Point	1968-70	M. edulis	18	12						
	Phippsburg	1965-69	M. arenaria	39	7						
	Biddeford Pool	1968-70	M. edulis	26	7						
	Eliot	1966-70	M. arenaria	45	22	9					
	Occasional stations(40)	1965-69	Mixed	62	16	4					
Maryland	Franklin City	1966-70	C. virginica	8	8						88
	Pocomoke Sound	1966-69	C. virginica	6	5						
	Tangier Sound	1966-70	C. virginica	10	5						
	Honga River	1966-70	C. virginica	10	8						
	Choptank River	1966-70	C. virginica	8	4						
	Eastern Bay	1966-70	C. virginica	10	8						
	Tollys Bar	1966-70	C. virginica	8	8	7					
	Herring Bay	1966-70	C. virginica	10	9	4					
	Cedar Point	1966-70	C. virginica	10	9						
	St. Mary's River	1966-70	C. virginica	8	7						
Mississippi	Pascagoula	1965-72	C. virginica	78	47						470
	Graveline	1965-72	C. virginica	79	56						
	Deer Island	1965-69	C. virginica	49	33						
	Biloxi Bay	1965-72	C. virginica	78	71	8					
	Pass Christian (Inshore)	1965-66	C. virginica	13	7						
	Pass Christian (Offshore)	1965-72	C. virginica	78	29	3					
	Bay St. Louis	1966-72	C. virginica	66	31	7					
	St. Joseph Point	1966-72	C. virginica	29	11	1					
New Jersey	Drum Beds	1966-72	C. virginica	69	69	3				2	219
	Maurice River	1966-72	C. virginica	50	50	1				1	
	Dividing Creek	1966-71	C. virginica	7	7	1					
	Lease 566-4960	1966-72	C. virginica	57	52	28				2	
	Cohansey	1966-72	C. virginica	49	49	16				1	
	Occasional stations(7)	1966-71	C. virginica	17	12	3					

TABLE 26. (CONTINUED)

New York	Mamaroneck	1966-69	M. mercenaria	36	34	37					1059
	Hempstead Harbor	1966-72	M. mercenaria	74	70	61					
	Oyster Bay	1966-72	M. mercenaria	73	54	48					
	Huntington Bay	1966-72	M. edulis	76	72	32					
	Nissequogue River	1966-72	M. edulis	76	70	30					
	Conscience Bay	1966-72	M. edulis	73	61	32					
	Southold	1969-72	C. virginica	36	32	26					
	Flanders Bay	1966-72	M. mercenaria	69	63	15					
	Mecox Bay	1966-72	C. virginica	67	65	16					
	Shinnecock Bay	1966-72	M. mercenaria	73	63	19					
	Moriches Bay	1966-72	M. mercenaria	71	49	13					
	Bellport Bay	1966-72	M. mercenaria	71	31	10					
	Sayville	1966-72	M. mercenaria	76	61	16					
	Amityville	1966-72	M. mercenaria	73	49	13					
	East Bay	1966-72	M. mercenaria	37	43	13					
	West Bay	1966-72	M. mercenaria	37	31	19					
	Occasional stations(8	1967-72	Mixed	9	9	3					
North Carolina	Wanchese	1966-72	C. virginica	72	49						1001
	Salvo	1966-72	C. virginica	71	38						
	Wysocking Bay	1966-70	C. virginica	63	33						
	Rose Bay	1966-72	C. virginica	71	46	3					
	Bay River	1966-72	C. virginica	71	69	2					
	Neuse River	1966-70	C. virginica	63	63						
	Point of Marsh	1966-72	C. virginica	71	53	2					
	West Bay	1967-72	C. virginica	58	34						
	Back Bay	1966-67	C. virginica	9	8						
	Jarrett Bay	1966-72	C. virginica	66	42						
	North River	[illegible]-72	C. virginica	64	48	2					
	Newport River	1966-72	C. virginica	63	56	3					
	Bogue Sound	1967-72	C. virginica	51	33						
	White Oak River	1966-70	C. virginica	63	30						
	New River	1966-72	C. virginica	72	61						
	Wrightsville Beach	1966-70	C. virginica	63	35						
	Southport	1966-72	C. virginica	72	32						
	Shallotte River	1966-70	C. virginica	63	38						
South Carolina	North Santee Bay	1965-68	C. virginica	41	10	4					610
	South Santee Bay	1965-68	C. virginica	40	14	3			2		
	Bull Creek	1969	C. virginica	12	2	2					
	Price Creek	1965-68	C. virginica	62	23	2					
	Inlet Creek	1965-68	C. virginica	62	21						
	Hog Island Channel	1965-68	C. virginica	61	33						
	Lando River	1965-68	C. virginica	62	31				1		
	Ashley River	1965-68	C. virginica	56	43	8			1		
	Fort Johnson	1969	C. virginica	12	4				1		
	Steamboat Creek	1965-69	C. virginica	36	26				1		
	Toogoodoo Creek	1965-69	C. virginica	53	40				1		
	Big Bay Creek	1965-69	C. virginica	36	32				1		
	St. Pierre Creek	1966	C. virginica	12	7						
	Whale Branch	1965-68	C. virginica	41	21						
	Shell Creek	1965-68	C. virginica	39	12	1			3		
	Hay Creek	1969	C. virginica	12	3	1			1		
	New River	1969	C. virginica	12	1	1					
	Occasional stations(6)	1965-68	C. virginica	7	5	2					
Texas	Trinity Bay	1965-69	C. virginica	47	28	1					728
	Galveston Bay	1965-72	C. virginica	71	60	31					
	Tres Palacios Bay	1965-72	C. virginica	76	71	6				2	
	Lavaca Bay	1965-72	C. virginica	66	59	4					
	San Antonio Bay, North	1965-72	C. virginica	59	38	8	1				
	San Antonio Bay, South	1965-72	C. virginica	75	60	3					
	St. Charles Bay	1966-72	C. virginica	66	33	11					
	Aransas Bay	1965-67	C. virginica	19	18	2					
	Copano Bay	1967-71	C. virginica	51	24					2	
	Red Fish Bay	1966-72	C. virginica	67	32						
	Nueces Bay	1965-68	C. virginica	20	20	4	3				
	Arroyo Colorado	1965-71	C. virginica	48	48	65	18	1			
	Lower Laguna Madre	1965-67	C. virginica	36	15	1				1	
	Occasional stations(16)	1965-72	C. virginica	61	26	16					
Virginia	Machipongo River	1965-72	C. virginica	67	56	2				1	669
	Cherrystone Inlet	1965-72	C. virginica	68	67					2	
	Bowlers Rock	1965-72	C. virginica	70	62					2	
	Urbana	1965-72	C. virginica	69	39					2	
	Bell Rock	1965-72	C. virginica	69	35					2	
	Pages Rock	1965-72	C. virginica	68	50	1				2	
	Deep Water Shoals	1965-72	C. virginica	69	69	38				3	
	Nansemond Ridge	1965-72	C. virginica	66	63	29				2	
	Hospital Point	1966-72	C. virginica	58	58	30				3	
	Lynnhaven Bay	1965-70	C. virginica	62	61	4					
	Occasional stations(4)	1965-67	C. virginica	5	5						
Washington	Stackpole Harbor	1965-66	C. gigas	38	9						695
	Olsen Slough	1966-68	C. gigas	30	7						
	Bear River	1965-68	C. gigas	38	3						
	Naselle River	1965-68	C. gigas	38	1	1					
	Nemah River	1965-68	C. gigas	39	4						
	Stony Point	1965-68	C. gigas	39	10						
	South Bend	1965-68	C. gigas	39	6						
	Beardslee Slough	1965-68	C. gigas	37	2						
	Oyehut	1966-68	C. gigas	36							
	Sequim Bay	1966-68	C. gigas	31							
	North Bay Reserve	1965-68	C. gigas	33							
	Oakland Bay Reserve	1965-68	C. gigas	33							
	Mud Bay	1965-68	C. gigas	32							
	Padilla Bay	1965-68	C. gigas	39	8						
	Swinomish	1965-68	C. gigas	38	1						
	Scott Point	1965-68	C. gigas	39	4						
	Rock Point	1965-66	C. gigas	37							
	Lummi	1965-68	C. gigas	38	23						
	Blaine	1965-68	C. gigas	48							
	Occasional stations(2)	1966	C. gigas	3							

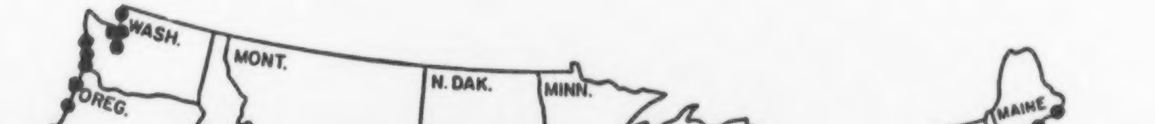
(a) Samples taken monthly
(b) Each sample represents 15 or more mature mollusks

Source: Butler (1973).


6 sites
3 sites
9 sites
13 sites
WASH.
MONT.
N. DAK.
MINN.
OREG.
IDAHO
WIS.
S. DAK.
WYO.
MICH.
CALIF.
NEV.
UTAH
NEBR.
IOWA
N.Y.
PA.
COLO.
KANS.
MO.
ILL.
IND.
OHIO
KY.
W.VA.
VA.
ARIZ.
N. MEX.
TEX.
OKLA.
ARK.
TENN.
N.C.
S.C.
GA.
ALA.
MISS.
LA.
FLA.
VT.
N.H.
MAINE
MASS.
CONN.
R.I.
N.J.
DEL.
3 sites
5 sites
10 sites
5 sites
9 sites
10 sites
10 sites
18 sites
17 sites
11 sites
2 sites
9 sites
2 sites
4 sites
8 sites
ALASKA
HAWAII

Source: Butler (1973).

FIGURE 6. MONITORING RESIDUES IN WILDLIFE -- ESTUARINE SHELLFISH COLLECTION SITES


WASH.
MONT.
N. DAK.
MINN.
OREG.
IDAHO
WIS.
S. DAK.
WYO.
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CALIF.
NEV.
UTAH
NEBR.
IOWA
N.Y.
PA.
COLO.
KANS.
MO.
ILL.
IND.
OHIO
KY.
W.VA.
VA.
ARIZ.
N. MEX.
TEX.
OKLA.
ARK.
TENN.
N.C.
S.C.
GA.
ALA.
MISS.
LA.
FLA.
VT.
N.H.
MAINE
MASS.
CONN.
R.I.
N.J.
DEL.
4 sites
3 sites
3 sites
6 sites
17 sites
5 sites
4 sites
2 sites
3 Gulf sites
ALASKA
HAWAII

Source: Butler, personal communication.

FIGURE 7. MONITORING RESIDUES IN WILDLIFE -- ESTUARINE FINFISH COLLECTION SITES

All samples are to be monitored for chlorinated hydrocarbon pesticides, organophosphorus pesticides, polychlorinated byphenyls, atrazine, ethylenethiourea compounds, phenoxy herbicides, arsenic, cadmium, lead, and mercury. Table 27 summarizes the FY 1973 estuarine monitoring program with regard to fin fish. The fish collection stations for the program are listed in Table 28 and are shown in Figure 7.

Fish

Since the spring of 1967, the BSFW has operated this element of the NPMP. The objective is to continuously monitor pesticide residue levels in fishes of the nation's lakes and rivers. Over the years, the program has undergone a number of changes and modifications.

Originally, indicator species from near the top of the food chain were collected from 50 locations in the Great Lakes and major river basins throughout the United States as shown in Figure 8. In 1970, the number of collecting locations was increased to 100 (Inglis et al 1971). These locations are shown in Figure 9. Table 29 lists the fish sampling locations by drainage and river system. At each sampling location, field personnel attempt to collect composite samples of each of three species, preferrably indicator species from near the top of the food chain. Each composite should consist of three to five uniform size adult fish of the same species (Henderson et al 1969).

The original sampling schedule specified that collections would be made in the spring and fall of each year. An evaluation of the data indicated little difference in residue levels in the spring and fall; thus, beginning in 1969, collections were made only once a year in the fall (September, October, November) when collecting the desired species is less difficult (Henderson et al 1971).

Initially, the composite samples were analyzed only for organochlorine insecticides (Henderson et al, 1969). Beginning in 1969, mercury was added ; and in 1970, lead, arsenic, cadmium, and selenium were added to the program (Henderson et al 1972; Berger, personal communication).

In 1967 and 1968 the samples were analyzed by three private laboratories. In 1969 and 1971, the samples were analyzed by a single private laboratory. In 1972 all analytical work was transferred to the Bureau's Denver Wildlife Research Center for economic and administrative reasons (Spencer 1974).

TABLE 27. MONITORING RESIDUES IN WILDLIFE -- SUMMARY OF ESTUARINE DATA RELATIVE TO MONITORING OF FINFISH (FY 1973)

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State	Number of		Number of Positive Samples and Percent Positive for Indicated Compound									Mercury Analysis	
	Stations	Samples (a)	DDTR	Dieldrin	PCB	Organo-phosphate	Heptachlor Epoxide	Chlordane	Endrin	Toxaphene	Benzpyrene	Number of Samples(a)	Number and Percent Positive
Alabama	1	4	3(75)									1	1(100)
Alaska	6	36									6 neg.	10	2(20)
California	5	27	23(85)	2(7)	2(7)							15	12(80)
Connecticut	4	11	4(36)	3(27)	11(100)							4	4(100)
Delaware	4	19	19(100)	2(11)	12(63)							13	9(69)
Florida	10	35	8(23)	1(3)								9	9(100)
Georgia	5	29	5(17)	2(7)	1(3)							16	11(69)
Hawaii	8	22			3(14)							14	11(79)
Maryland	6	67	40(60)	19(28)	25(37)	15(22)	3(4)	6(9)				42	6(14)
Mississippi	3	20	6(30)										
New York	3	15	7(47)	2(13)	5(33)							7	7(100)
North Carolina	17	111	65(59)	55(50)	16(14)							26	20(77)
Oregon	5	78	21(30)		4(5)							27	27(100)
Puerto Rico	2	12	3(25)		4(33)							8	6(75)
Rhode Island	1	12			7(58)						4 neg.	6	6(100)
South Carolina	6	27	15(56)		1(4)							23	15(65)
Texas	5	37	29(78)	12(32)	3(8)	2(5)			5(7)	17(25)			
Virgin Islands	12	18			3(17)							13	11(85)
Virginia	3	42	36(86)	8(19)	15(36)							24	10(42)
Washington	6	67	1(1)		12(18)							48	37(77)
Totals	112	689	285(41)	106(15)	124(18)	17(2)	3(0.4)	6(0.9)	5(0.7)	17(2)	(d)	306	204(67)

Note: Blanks represent zeros

(a) Each sample represents 25 herbivorous and 25 carnivorous fish uniform in size and not more than one year in age taken every 6 months.

Source: Butler, personal communication (1974).

TABLE 28. MONITORING RESIDUES IN WILDLIFE -- ESTUARINE FINFISH COLLECTION SITES (1972-1974)

ALABAMA

Mobile Bay
Portersville Bay

ALASKA

Auke Bay
Icy Strait
Idaho Strait
Lisianski Inlet
Kachemak Bay
Chignik Bay
Kotzebue Sound
Point Barrow

CALIFORNIA

Humboldt Bay
San Francisco Bay
Elkhorn Slough
Los Angeles Harbor
Mission Bay

CONNECTICUT

Thames (New London)
Connecticut River (Middlesex)
Quinnipiac River (New Haven)
Housatonic (Fairfield)

DELAWARE

Delaware Bay
Chesapeake & Delaware Canal
Indian River/Rehoboth Bay

FLORIDA

Fakahatchee Bay
Rookery Bay
Port Charlotte (USF)
Caloosahatchee River (USF)
Peace River (USF)
Tampa Bay (USF)
Anclote River (USF)
Suwannee River
St. Andrews Bay (NMFS)
Pensacola Bay
Gulf of Mexico
Gulf of Mexico
Gulf of Mexico

GEORGIA

Savannah River
St. Catherine Sound
Altamaha Sound
St. Simons Sound
St. Andrews Sound

HAWAII

Kona (Hawaii)
Coconut Island, Hilo Bay
Maalaea Bay (Maui)
Lahaina Bay (Maui)
Kaneohe Bay (Oahu)
Captain Cooks Landing (Kauai)
Lihue Bay (Kauai)
Nawiliwili Harbor (Kauai)

MAINE

Machias Bay
Penobscot Bay
Casco Bay
Portsmouth Harbor

MARYLAND

Patapsco River
Potomac River
Patuxent
South River
Susquehanna Flats
Choptank River

MISSISSIPPI

Pascagoula River
Ocean Springs
Biloxi Bay
St. Louis Bay

NEW YORK

West Long Island Sound
Gardiners Bay
Great South Bay

NORTH CAROLINA

Ocracoke
Big Foot Slough (Neuse)
Minnesott Beach (Neuse)
Garbacon Shoal (Adams Creek)
Bay River (Neuse)
Abel Bay (Pamlico)
Rose Bay (Pamlico)
Broatan, North (Albermarle)
Alligator River (Albermarle)
Pasquotanka River
Beaufort Bar (Core Creek)
Bogue Sound
Queens Creek (White Oak)
Old Topsail Inlet (Cape Fear)
Carolina Beach Inlet (cape Fear)
Shallotte Inlet (Coastal)
Cape Fear River

OREGON

Coos Bay
Umpqua River
Yaquina Bay
Tillamook Bay
Columbia River

PUERTO RICO

Punta Congrejos
Mayaguez

RHODE ISLAND

Narragansett Bay

SOUTH CAROLINA

South Santee
Winyah Bay
Charleston Harbor
St. Helena Sound
South Edisto
Port Royal Sound

TEXAS

Laguna Madre
Port Harlingen/Arroyo City
Oso Bay
Aransas Bay
Brazos River (+ Christmas Bay)

VIRGINIA

James River
York River
Rappahannock River

VIRGIN ISLANDS

David Point (St. Thomas)
Mangrove Lagoon (St. Thomas)
Coral Bay (St. John)
Cruz Bay (St. John)
Mary Creek (St. John)
Butler Bay (St. Croix)
East End Point
Good Hope (St. Croix)
Harvey Ditch (St. Croix)
Rust Up Twist (St. Croix)
Salt River Bay (St. Croix)
Tague River

WASHINGTON

Willapa Bay
Grays Harbor
Bellingham Bay
Hood Canal (Puget Sound)
Duamish (Puget Sound)
Nisqually River

Source: Butler, personal communication (1974).

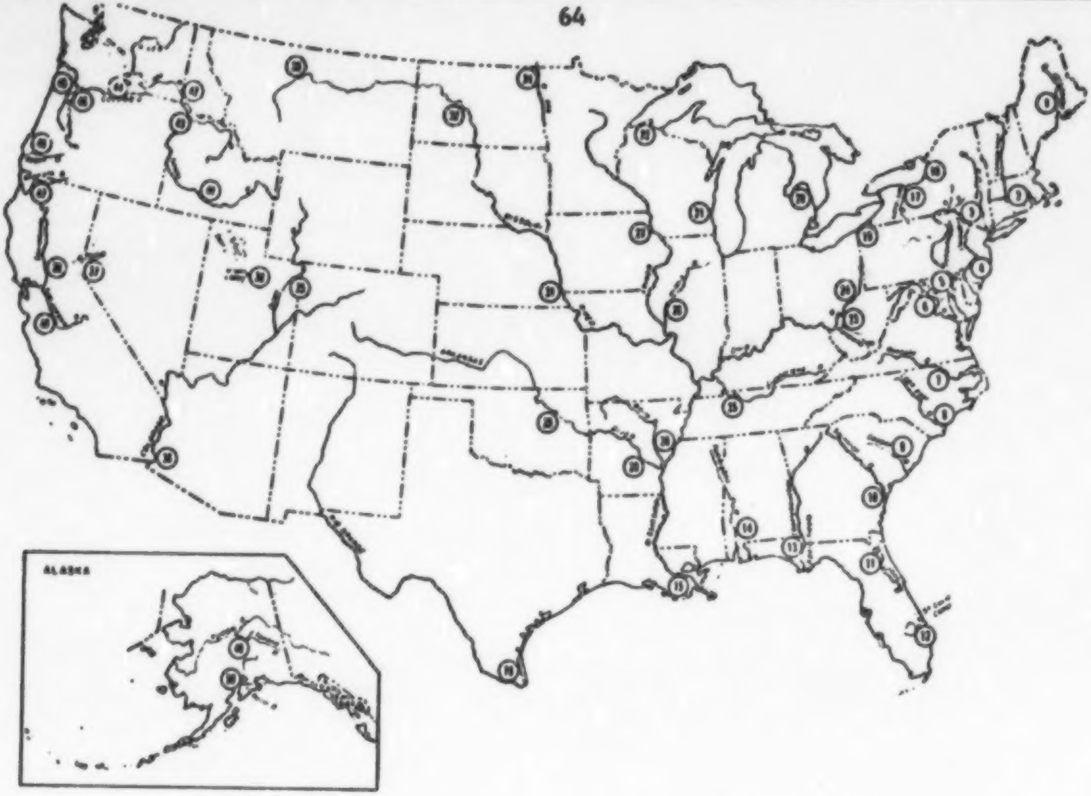

FIGURE 8. MONITORING RESIDUES IN WILDLIFE -- ORIGINAL FISH COLLECTION LOCATIONS (1967-1969)
Source: Henderson et al (1969).

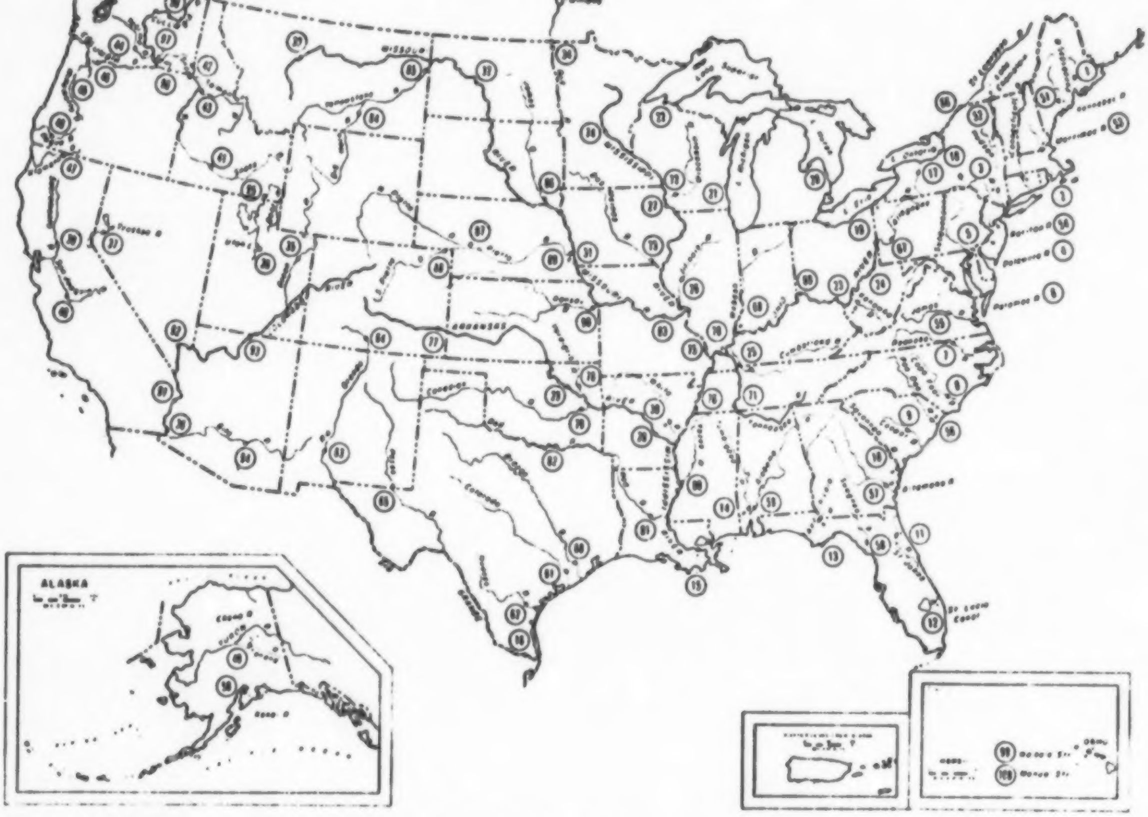

FIGURE 9. MONITORING RESIDUES IN WILDLIFE -- REVISED FISH COLLECTION LOCATIONS (1970-Present)
Source: Henderson et al (1972).

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TABLE 29. MONITORING RESIDUES IN WILDLIFE -- FISH SAMPLING LOCATIONS

Drainage and River System	Location	Station Number[a]
ATLANTIC COASTAL STREAMS		
Penobscot River (Stillwater River)	Old Town, Maine	1
Kennebec River	Hinckley, Maine	51
Lake Champlain	Burlington, Vt.	52
Merrimac River	Lowell, Mass.	53
Connecticut River	Windsor Locks, Conn.	2
Hudson River	Poughkeepsie, N.Y.	3
Raritan River	Highland Park, N.J.	54
Delaware River	Camden, N.J.	4
Susquehanna River	Conowingo, Md.	5
Potomac River	Little Falls, Md.	6
James River	Richmond, Va.	55
Roanoke River	Roanoke Rapids, N.C.	7
Cape Fear River	Elizabethtown, N.C.	8
Pee Dee River	Dongola, S.C.	56
Cooper River	Summerton, S.C.	9
Savannah River	Savannah, Ga.	10
Altamaha River	Docktortown, Ga.	57
St. Johns River	Welaka, Fla.	11
St. Lucie Canal	Indiantown, Fla.	12
GULF COASTAL STREAMS		
Suwanee River	Old Town, Fla.	58
Apalachicola River	Jim Woodruff Dam, Fla.	13
Alabama River	Chrysler, Ala.	59
Tombigbee River	McIntosh, Ala.	14
Mississippi River	Luling, La.	15
Brazos River	Richmond, Tex.	60
Colorado River	Wharton, Tex.	61
Nueces River	Mathis, Tex.	62
Rio Grande River	Brownsville, Tex.	16
Rio Grande River	Elephant Butte, N. Mex.	63
Rio Grande River	Alamosa, Colo.	64
Pecos River	Red Bluff Lake, Tex.	65
GREAT LAKES DRAINAGE		
Gennessee River	Scotsville, N.Y.	17
St. Lawrence River	Massena, N.Y.	66
Lake Ontario	Port Ontario, N.Y.	18
Lake Erie	Erie, Pa.	19
Lake Huron	Bay Port, Michigan	20
Lake Michigan	Sheboygan, Wisconsin	21
Lake Superior	Bayfield, Wisconsin	22
MISSISSIPPI RIVER SYSTEM		
Allegheny River	Natrona, Pa.	67
Kanawha River	Winfield, W. Va.	23
Wabash River	New Harmony, Ind.	68
Ohio River	Marietta, Ohio	24
Ohio River	Cincinnati, Ohio	69
Ohio River	Metropolis, Ill.	70
Cumberland River	Clarksville, Tenn.	25
Tennessee River	Savannah, Tenn.	71
Wisconsin River	Woodman, Wisconsin	72
Des Moines River	Keosauqua, Iowa	73
Illinois River	Beardstown, Ill.	26
Mississippi River	Little Falls, Minn.	74
Mississippi River	Guttenburg, Iowa	27
Mississippi River	Cape Girardeau, Mo.	75
Mississippi River	Memphis, Tenn.	76
Arkansas River	Pine Bluff, Ark.	28
Arkansas River	Keystone Reservoir, Okla.	29
Arkansas River	John Martin Reservoir, Colo.	77
MISSISSIPPI RIVER SYSTEM - Continued		
Verdigris River	Oologah, Okla.	78
Canadian River	Eutaula, Okla.	79
White River	DeValls Bluff, Ark.	30
Yazoo River	Redwood, Miss.	80
Red River	Alexandria. La.	81
Red River	Lake Texoma, Okla.	82
Missouri River	Hermann, Mo.	83
Missouri River	Nebraska City, Nebr.	31
Missouri River	Garrison Dam, N. Dak.	32
Missouri River	Great Falls, Mont.	33
Big Horn River	Hardin, Mont.	84
Yellowstone River	Sidney, Mont.	85
James River	Olivet, S. Dak.	86
North Platte River	Lake McConaughy, Nebr.	87
South Platte River	Brule, Nebr.	88
Platte River	Louisville, Nebr.	89
Kansas River	Bonner Springs, Nebr.	90
HUDON BAY DRAINAGE		
Red River (North)	Noyes, Minn.	34
COLORADO RIVER SYSTEM		
Green River	Vernal, Utah	35
Colorado River	Imperial Reservoir, Ariz.	36
Colorado River	Lake Havasu, Ariz.	91
Colorado River	Lake Mead, Ariz.	92
Colorado River	Lake Powell, Ariz.	93
Gila River	San Carlos Reservoir, Ariz.	94
INTERIOR BASINS		
Truckee River	Fernley, Nev.	37
Utah Lake	Provo, Utah	38
Bear River	Preston, Idaho	95
CALIFORNIA STREAMS		
Sacramento River	Sacramento, Calif.	39
San Joaquin River	Los Banos, Calif.	40
COLUMBIA RIVER SYSTEM		
Salmon River	Riggins, Idaho	43
Snake River	Hagermann, Idaho	41
Snake River	Lewistown, Idaho	42
Snake River	Ice Harbor, Wash.	96
Yakima River	Granger, Wash.	44
Wilamette River	Oregon City, Oregon	45
Columbia River	Bonneville, Oregon	46
Columbia River	Pasco, Wash.	97
Columbia River	Grand. Coulee, Wash.	98
PACIFIC COASTAL STREAMS		
Klamath River	Hornbrook, Calif.	47
Rogue River	Gold Ray Dam, Oregon	48
ALASKAN STREAMS		
Chena River	Fairbanks, Alaska	49
Kenai River	Soldatna, Alaska	50
HAWAIIAN STREAMS		
Waikele Stream	Waipahu, Hawaii	99
Manoa Stream	Honolulu, Hawaii	100

Source: Inglis et al (1971).

Since the program was initiated, some 1700 composite samples have been collected and analyzed. Table 30 summarizes the data available to date with respect to the species monitored and number of samples per species. Table 31 presents data concerning the chemicals monitored and the number of samples per location.

Mallard and Black Ducks

As mallard and black ducks fit the stated selection criteria and as wings were already being collected by the Bureau of Sport Fisheries and Wildlife (BSFW) to determine sex and age ratios, these organisms were considered as potential environmental indicators of pesticides. Studies by Dindal and Peterle (1968) and Heath and Prouty (1967) demonstrated that significant correlations could be established between pesticide levels in wings and pesticide levels in body tissue. As a result, the first full-scale monitoring effort was conducted in the winter of 1965-1966. The data from this initial monitoring effort established the base readings from which future trends in residue levels would be measured and geographic comparisons made (Heath 1969).

The objective of this element of the NPMP is to quantify not only levels but also spatial and temporal trends in levels of pesticides and pollutants in continental populations of mallards and black ducks (Heath and Hill 1974). To accomplish this objective, wing monitoring is conducted at 3-year intervals.

Samples are collected from wings mailed to one of four regional collection points by hunters who have taken birds in their respective states during the legal hunting season (Heath and Hill 1974). The wings are sorted into pools of 25 each; the number of pools per state is determined by the number of ducks harvested per state. Each sample, therefore, consists of a composite of 25 wings. Chemical analyses are performed on these pools of wings, rather than individual wings, in order to increase the precision of estimates of average residue levels (Heath, 1969).

Table 32 presents the compiled data relative to this program. As seen from the table, determinations of mercury and PCB residues were not made until the 1970 sampling period.

TABLE 30. MONITORING RESIDUES IN WILDLIFE - FISH SPECIES AND NUMBER OF SAMPLES COLLECTED (1967-1972)

Fish Species Collected		Number of Samples(a) Per Year						
Family	Common Name	1967	1968	1969	1970(f)	1971(g)	1972	Totals
Amiidae-Bowfins	Bowfin	1	1	(b)/(c)	(d)-(e)		(d)-(e)	2/
Clupeidae - Herrings	American Shad							
	Gizzard Shad	3	3	2/2	6-3		5-3	13-3/13-6
Salmonidae - Trouts, Whitfish and Graylings	Lake Whitefish	3	2	1/1	1-1		1	7/3-1
	Bloater	3	3	2/2	2-1		2-2	10-2/6-3
	Round Whitefish	1	4	1/1	2		2	8/5
	Mountain Whitefish	1	1		1			2/1
	Brown Trout				1		1	1/2
	Coho Salmon	2						2/
	Sockeye Salmon	1						1/
	Cutthroat Salmon		1					1/
	Rainbow Trout	7	2	3/3	4		2	14/9
	Lake Trout	3	4	2/2	2		3-3	12-3/7-3
	Arctic Grayling	1	1	1/1	1		1	4/3
Hiodontidae - Mooneyes	Goldeye	4	5	3/3	7-5		6-5	18-5/16-10
	Mooneye		1				1	2/1
Esocidae-Pikes	Chain Pickerel	2	2	1/1	2		2	7/5
	Northern Pike	1	1		3		3-1	5-1/6-1
Cyprinidae - Minnows and Carps	Chiselmouth	1	1	2/2				4/2
	Goldfish	1	2	1/1	1-1		1-1	5-1/3-2
	Peamouth Chub						1	1/1
	Sacramento Blackfish						1	1/1
	River Carpsucker				1-1		2-1	2-1/3-2
	River Chub						1-1	1-1/1-1
	Carp	52	42	22/22	56-24		55-20	171-20/133-44
	Golden Shiner	1			1		1	2/2
	Northern Squawfish	9	8	3/3	5-1		8-1	28-1/16-2
	Tui Chub	1						1/
Catostomidae - Suckers	Carpsucker	1	2		2-1			3/2-1
	Longnose Sucker	4	5	2/2	1		1-1	12-1/4-1
	Bridge Lip Sucker	2	2	1/1	2		1	6/4
	White Sucker	14	12	7/6	10-5		11-3	44-3/27-8
	Flannelmouth Sucker		1	1/1	1-1		1-1	3-1/3-2
	Large Scale Sucker	15	10	6/6	8-6		9-6	40-6/23-12
	Klamath Sucker		1	1/1	1			2/2
	Tahoe Sucker		1					1/
	Lake Chubsucker	1						1/
	Smallmouth Buffalo	3	2	1/1	4-3		8-3	14-3/13-6
	Bigmouth Buffalo	7	3	2/2	3-1		1	13/6-1
	Spotted Sucker	6	4	2/2	3-1		3-2	15-2/8-3
	Redhorse Sucker	4	7	3/3	4-2		6-1	20-1/13-3
	Humpback Sucker	1						1/
Ictaluridae - Freshwater Catfishes	White Catfish	6	2	2/2	4-2		4-2	14-2/10-4
	Blue Catfish		2	1/1	1		5	8/7
	Black Bullhead	5	5	2/2	2-1		1-1	13-1/18-6
	Brown Bullhead	14	12	6/6	6-3		6-3	38-3/18-6
	Chinese Catfish				2-2		2-2	2-2/4-4
	Yellow Bullhead				1		2	2/3
	Channel Catfish	27	29	13/13	33-8		31-5	100-5/77-13
	Flathead Catfish	3	1	1/1	1			5/2
Gadidae-Codfishes and Hakes	Burbot	1						1/
Serranidae - Sea Basses	White Perch	8	7	3/3	5-2		5-2	23-2/13-4
	White Bass	2	2	1/1	1		1	6/3
	Striped Bass	1						1/
Centrarchidae - Sunfishes	Rock Bass	3	4	2/2	3		2	11/7
	Sacramento Perch	1						1/
	Redbreasted Sunfish	2	1	1/1	1-1		2	6/4-1
	Spotted Bass				1			/1
	Green Sunfish	1	1		1		1	3/2
	Pumpkinseed	1	2	1/1	3		2	6/6
	Bluegill	9	12	6/6	15-3		12-5	39-5/33-8
	Smallmouth Bass	4	3	2/2	4		4-1	13-1/10-1
	Largemouth Bass	24	29	16/15	33-4		29-4	98-4/77-8
	White Crappie	3	4	4/3	7-2		6-3	17-3/16-5
	Black Crappie	1	3	3/3	2-1		1	8/6-1
Percidae - Perches	Yellow Perch	15	14	7/8	13-8		12-11	48-11/33-19
	Sauger	2	4	1/1	3		4-2	11-2/12-2
	Walleye	3	4	2/2	5-1		5-1	14-1/12-2
Sciaenidae-Drums	Freshwater Drum	3	3	1/1	6		6-2	13-2/13-2
Musilidae-Mullets	Striped Mullet	5	6	2/2	3-2		3	16/8-2
Lepisosteidae - Gars	Longnose Gar				1		1	1/2
	Spotted Gar						1	1/1
Miscellaneous	Tilapia				2		2	2/4
	Cuban Limia				2		2	2/4
Totals		300	284	147/145	393(h)		391(h)	1122(h)/929(h)

(a) Each sample represents 3 to 5 fish

(b) Number of samples analyzed for chlorinated hydrocarbons and PCB's

(c) Number of samples analyzed for mercury

(d) Initial samples

(e) Replicate samples

(f) Data not available for chlorinated hydrocarbons

(g) Data not available

(h) Includes replicate samples

Source: Henderson et al (1969, 1971, 1972); Berger, personal communication (1974).

TABLE 31. MONITORING RESIDUES IN WILDLIFE - SUMMARY OF DATA WITH RESPECT TO FISH MONITORING PROGRAM

	Calendar Year					
Chemical	1967 (Spring & Fall)	1968 (Spring & Fall)	1969 (Fall)	1970(g) (Fall)	1971(h) (Fall)	1972 (Fall)
DDE	x	x	x			x
DDD						x
TDE	x	x	x			
DDT	x	x	x			x
DDT and Metabolites	x	x	x			x
Dieldrin	x	x	x			x
Aldrin	x	x				
Endrin	x	x				x
Lindane	x	x				
Heptachlor	x	x	x			
Heptachlor Epoxide	x	x	x			x
Chlordane	x	x	x			
Toxaphene	x					x
BHC			x			
PCB's			x			x
Mercury			x	x		x
Lead						x
Arsenic						x
Cadmium						x
Selenium						x
Total Number of Sample Sites	50	50	50	100	100	100
Samples(a) Per Location			(b)/(c)	(d)-(e)		(d)-(e)
Atlantic Coast Streams	73	70	36/36	57-19		59-19
Gulf Coast Streams	24	24	12/11	36-12		38-11
Great Lakes Drainage	32	32	18/17	20-7		19-10
Mississippi River System	72	67	33/33	105-35		100-34
Hudson Bay Drainage	7	6	2/2	3-1		3-1
Colorado River System	12	12	6/6	17-5		18-6
Interior Basins	11	11	6/6	9-3		9-3
California Streams	12	12	6/6	6-2		6-2
Columbia River System	36	27	16/16	25-9		26-8
Pacific Coast Streams	9	11	6/6	6-2		2-1
Alaskan Streams	12	12	6/6	6-0		6-2
Hawaiian Streams				6-2		6-2
Total Number of Samples	300	284	147/145	393(f)		391(f)

(a) Each sample represents a composite of 3 to 5 fish
(b) Number of samples analyzed for chlorinated hydrocarbons and PCB's
(c) Number of samples analyzed for mercury
(d) Initial samples taken
(e) Replicate samples; usually 1 per site
(f) Including replicate samples
(g) Data not available for chlorinated hydrocarbons
(h) Data not available

TABLE 32. MONITORING RESIDUES IN WILDLIFE - SUMMARY OF MALLARD AND BLACK DUCK MONITORING DATA

	Fiscal Year[(a)]		
	1966-1967	1970	1973[(d)]
Chemical			
DDT and Metabolites	x	x	
Dieldrin	x	x	
Heptachlor Epoxide	x		
Lindane	x		
PCB's[(c)]		x	
Mercury[(c)]		x	
Location Showing Number of Samples Per Location			
Black Ducks, Atlantic Flyway			
Maine	8	3	
Vermont	6	2	
New Hampshire	6	2	
Massachusetts	8	4	
Connecticut	6	3	
Rhode Island	6	3	
New York	8	4	
Pennsylvania	6	3	
New Jersey	10	5	
Delaware	6	2	
Maryland	6	3	
Virginia	6	3	
North Carolina	3	2	
South Carolina	4	2	
Mallards, Atlantic Flyway			
New York	6	3	
Pennsylvania	6	3	
New Jersey	6	3	
Maryland	5	2	
Virginia	6	2	
South Carolina	6	3	
Georgia and Florida	4	2	
Mallards, Mississippi Flyway			
Minnesota	13	5	
Wisconsin	8	5	
Michigan	5	3	
Iowa	10	4	
Illinois	13	6	
Indiana	7	1	
Ohio	6	3	
Missouri	11	5	
Kentucky	6	1	
Arkansas	13	6	
Tennessee	9	4	
Louisiana	11	5	
Mississippi	6	2	
Alabama	5	1	
Mallards, Central Flyway			
Montana (East)	12	4	
North Dakota	16	6	
South Dakota	15	6	
Wyoming (East)	4	3	
Nebraska	13	7	
Colorado	14	4	
Kansas	13	6	
New Mexico (East)	6	3	
Oklahoma	9	4	
Texas	15	6	
Mallards, Pacific Flyway			
Washington	24	8	
Oregon	14	7	
Idaho	18	8	
Montana (East)	8	4	
Wyoming (East)	5	2	
California	22	8	
Nevada	5	3	
Utah	11	5	
Colorado (West)	6	3	
Arizona and New Mexico	4	3	
Total Number of Samples[(b)]	485	210	

(a) Collection takes place during legal hunting season every three (3) years
(b) Each sample represents a "pool" of 25 unfeathered duck wings
(c) Determinations made beginning in 1970
(d) Samples have been taken, but no analysis made

Starlings

As part of the NPMP, the BSFW has used starlings as an indicator species for measuring the occurrence and levels of selected persistent environmental contaminants (Martin 1972). These birds fit the selection criteria of the Wildlife Monitoring Program, are generally considered as a pest species and thus expendable, and have omnivorous food habits which could reflect the presence of persistent pesticides and selected metals in the environment (Dustman et al 1971).

Starlings were first monitored for organochlorine residue levels in 1967 with birds being collected from 128 of 139 sample sites. Sample sites were randomly selected by dividing the 48 contiguous states into blocks of 5 degrees latitude and longitude. One to four sampling sites were then selected per block (Martin 1969). At each site, pools of ten birds are collected, composited, and treated as one sample. Figure 10 shows the present sampling locations for the starling program.

A multitude of data were collected in the 1967-1968 period to determine if organochlorine insecticide residues could be consistently detected in starlings. These data indicated that residues could be detected; thus, starlings were considered a valid indicator organism for the wildlife program. These data also formed the "baseline residue index" of persistent organochlorine insectides in starlings (Martin 1969).

In 1970, the starling program was redesigned so as to monitor organochlorine insectides on even years, and selected metals on odd years. For monitoring heavy metal residues, 53 preselected sites as shown in Figure 11 were chosen to reflect varying environmental conditions representing broad geographic areas and including differing degrees of human activity and related pollution sources (Martin and Nickerson 1973). At each site, one composite sample consisting of ten starlings is obtained for analysis.

Table 33 presents a compilation of the data available for this program to date.

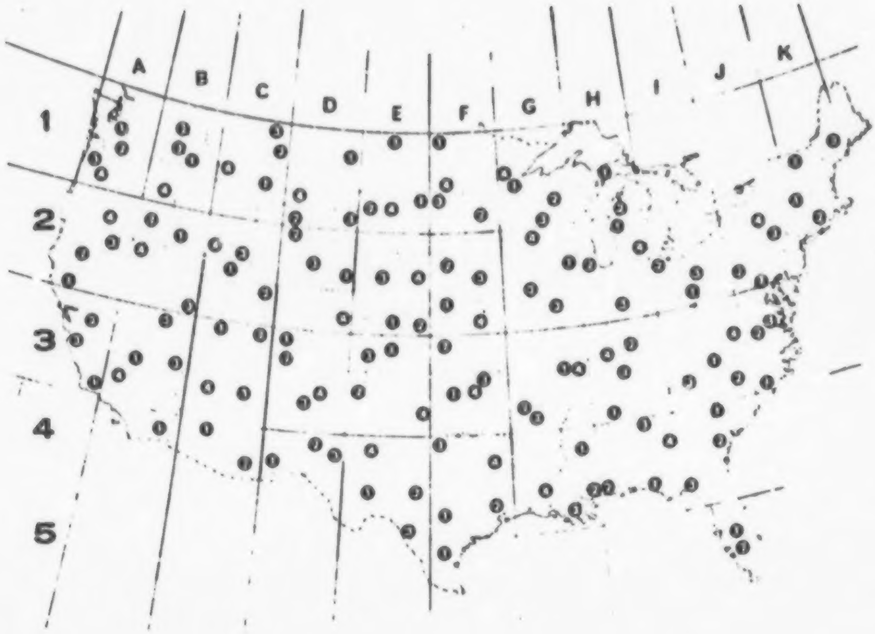

FIGURE 10. MONITORING RESIDUES IN WILDLIFE -- COLLECTION SITES FOR MONITORING PESTICIDE RESIDUES IN STARLINGS
Source: Martin et al (1972).

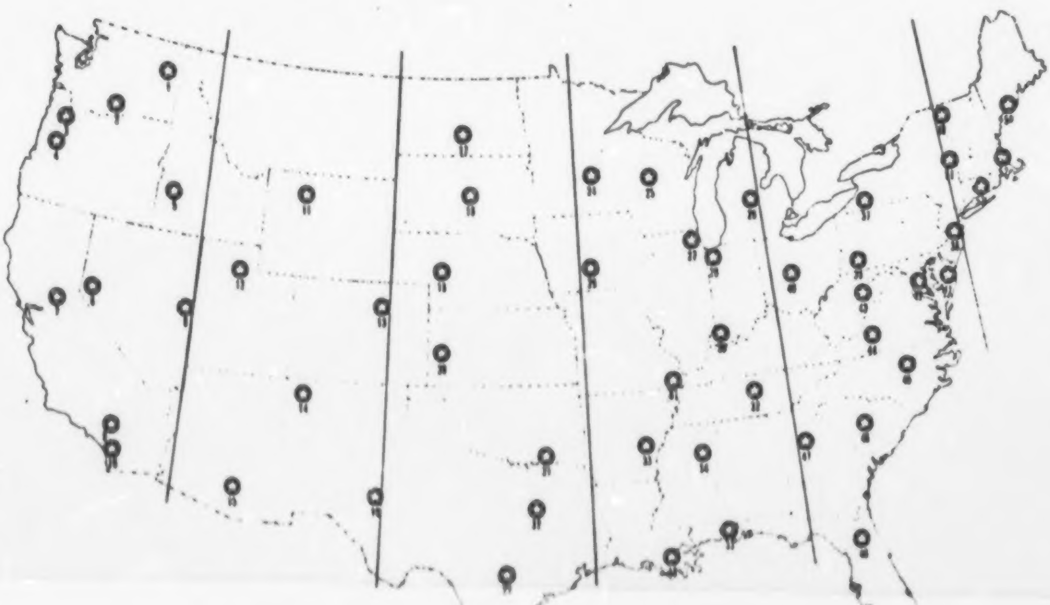

FIGURE 11. MONTIORING RESIDUES IN WILDLIFE -- COLLECTION SITES FOR MONITORING HEAVY METAL RESIDUES IN STARLINGS
Source: Martin et al (1973).

TABLE 33. MONITORING RESIDUES IN WILDLIFE - SUMMARY OF STARLING MONITORING DATA

	Calendar Year and Collection Period					
	1967	1968	1970	1971	1972	1973
Chemical(a)	Aug-Sept	Jan-Feb and Nov	Nov-Dec	Nov-Dec	Nov-Dec	Nov-Dec
BHC		x	x		x	
DDT and Metabolites	x	x	x		x	
Dieldrin	x	x			x	
Heptachlor Epoxide	x	x			x	
Lindane	x	x				
PCB's			x		x	
HCB					x	
Oxychlordane					x	
Metals(b) (First Monitored)						
Mercury (1970)			x	x		x
Lead (1970)			x	x		x
Arsenic (1971)				x		x
Cadmium (1971)				x		x
Selenium (1973)						x
Location Showing Number of Samples Per Location						
Alabama	2	2	2	1		
Arizona	4	4	4(c)	1		
Arkansas	2	2	2(c)	1		
California	9	9	9	3		
Colorado	4	4	4(c)	1		
Connecticut	1	1	1	1		
Delaware				1		
Florida	4	4	4(c)	1		
Georgia	2	2	2(c)	1		
Idaho	4	4	4(c)	1		
Illinois	3	3	3(c)	1		
Indiana	1	1	1	1		
Iowa	3	3	3	1		
Kansas	5	5	5	1		
Kentucky	2	2	2			
Louisiana	2	2	2(c)	1		
Maine	1	1	1(c)	1		
Maryland	1	1	1(c)	1		
Massachusetts				1		
Michigan	4	4	4	1		
Minnesota	3	3	3(c)	1		
Mississippi	3	3	3	1		
Missouri	2	2	2	1		
Montana	6	6	4			
Nebraska	4	4	4	1		
Nevada	4	4	4(c)	2		
New Jersey			(c)	1		
New Mexico	5	5	5	2		
New York	1	1	2(c)	1		
North Carolina	4	4	4(c)	1		
North Dakota	3	3	3	1		
Ohio	3	3	3(c)	1		
Oklahoma	4	4	4(c)	1		
Oregon	5	5	5(c)	2		
Pennsylvania	2	2	2	1		
South Carolina	1	1	1	1		
South Dakota	4	4	3(c)	1		
Tennessee	1	1	1(c)	1		
Texas	1	1	2	2		
Utah	4	4	2(c)	1		
Vermont	1	1	1	1		
Virginia	3	3	3	1		
Washington	4	4	4(c)	2		
West Virginia				1		
Wisconsin	2	2	2	1		
Wyoming	4	4	4			
Total Number of Samples(e)	128	128	125	50	130(d)	52(d)

(a) Beginning in 1972 these are monitored in even numbered years only

(b) Beginning in 1971 these are monitored in odd numbered years only

(c) Aside from what is shown, 1 additional sample was taken in 1970 from representative cities of these states for lead analysis (2 additional samples from Ohio)

(d) Actual locations unknown but assumed to be essentially the same as previous organochlorine and heavy metal sample sites

(e) Each sample represents a "pool" of 10 birds

ANALYTICAL METHODOLOGIES

The effects which analytical chemical methods can have on statistical design and analytical integrity are implicit in all monitoring systems. In general, the more sophisticated the statistical design and analysis, the greater the care that must be taken with the chemical analytical methods in order to satisfy the mathematical assumptions and requirements for valid statistical analysis. Erroneous data, or data which cannot be easily and accurately correlated, are often worse than no data at all. Thus, an assessment of the NPMP would not be complete without consideration of the analytical methods which have been employed at various times by the NPMP subprograms to detect, identify, and measure pesticide residue levels.

In the past, it was common practice for elements of the NPMP to utilize a number of commercial laboratories to conduct the sample analyses. Interlaboratory variations can have the effect of reducing the comparability, and hence, the value, of the resultant data. For instance, the fish monitoring program utilized five commercial laboratories for the analysis of specimens collected in 1967-1968. Subsequent cross-checking of shared samples revealed that residues reported on the shared fish samples sometimes varied by several orders of magnitude (Spencer 1974). As a further indication of the problem of interlaboratory variations, the tabulation on page 74 presents the results of an environmental check sample program wherein three different samples of fish tissue were submitted to a number of analytical laboratories. The large range of values in each case seems to be caused by differences in sample treatment or preparation along with intrinsic differences in the analytical procedures chosen (Reimers et al 1973).

The individuals responsible for the NPMP have apparently recognized such problems and have made efforts to reduce the variations attributable to analytical methodologies by using a more centralized approach to sample analysis. Currently, analyses of samples collected by the NPMP subprograms are conducted as shown in the tabulation on page 75.

Method	ppm Hg/wet weight		
	Sample D	Sample E	Sample F
Flameless Atomic Absorption Spectroscopy	1.46	0.04	4.53
Dithizone Photometric Spectroscopy	1.31	0.05	3.98
Pyrolysis	1.52	0.04	7.20
Neutron Activation	1.34	0.04	4.25
Flame Atomic Absorption Spectroscopy	1.80	<0.05	5.40
Flameless Atomic Absorption Spectroscopy	1.18	0.18	5.21
Flame Atomic Absorption Spectroscopy	1.21	0.06	3.57
Pyrolysis	0.47	0.10	2.0
Flame Atomic Absorption Spectroscopy	1.40	0.10	4.0
Flameless Atomic Absorption Spectroscopy	1.80	0.10	0.50
Neutron Activation	1.77	0.12	4.56
Flameless Atomic Absorption Spectroscopy	1.34	0.11	3.73
Flame Atomic Absorption Spectroscopy	0.72	0.06	2.26
Flameless Atomic Absorption Spectroscopy	1.7	<0.1	4.6
Flameless Atomic Absorption Spectroscopy	1.26	0.11	5.4
Neutron Activation	0.95	0.19	2.83
Flame Atomic Absorption Spectroscopy	1.31	0.49	3.35
Flameless Atomic Absorption Spectroscopy	1.16	0.04	2.87
Flameless Atomic Absorption Spectroscopy	1.04	<0.05	4.12
Flameless Atomic Absorption Spectroscopy	1.45	0.08	4.55
Flameless Atomic Absorption Spectroscopy	1.43	0.21	5.38
Neutron Activation	1.29	0.07	4.06
Neutron Activation	1.5	0.18	4.6
Flameless Atomic Absorption Spectroscopy	1.39	0.06	4.14
Dithizone Titration	0.095	<0.03	0.088
Flameless Atomic Absorption Spectroscopy	0.93	<0.05	2.8
Neutron Activation	1.4	0.05	
Average	1.27±0.39	0.12±0.10	3.85±1.53
Range	1.80 to 0.095	0.49 to 0.03	7.20 to 0.088

Source: Reimers et al (1973).

Environmental Media	Laboratory
Food and Feed	
Market Basket	HEW, Kansas City Field Office (Centralized Laboratory
Surveillance Program	Field Laboratories of the FDA
Meat and Poultry	USDA, Meat and Poultry Inspection Laboratories
Human Tissue	EPA, Contract Laboratories
Soils	EPA, National Pesticide Monitoring Laboratory Bay St. Louis, Missouri
Water	EPA, National Pesticide Monitoring Laboratory Bay St. Louis, Missouri
Wildlife	
Eagles	Patuxent Wildlife Research Center
Estuarine Fish	EPA, National Pesticide Monitoring Laboratory Bay St. Louis, Missouri
Fish	Wisconsin Alumni Research Foundation
Mallard and Black Ducks	Wisconsin Alumni Research Foundation
Starlings	Wisconsin Alumni Research Foundation Denver Wildlife Research Center (Heavy Metals)

Source: Spencer, 1974

While such an approach will serve to reduce the interlaboratory variations, it will not necessarily increase analytical precision and accuracy. Furthermore, it will not reveal intrinsic fluctuations introduced in the analytical procedures.

As with the various NPMP sampling procedures and experimental designs, analytical techniques used by the NPMP have reflected the influence of time and subprogram direction. Furthermore, analytical techniques used to measure pesticide residue levels are often of questionable accuracy and reliability and require rigorous quality control measures. There is ample documentation describing the interferences of improperly cleaned solvents and glassware, operator sensitivity, contaminated samples, and other factors. However, the use of different types of columns, carrier gases, gas flow rates, column temperatures, electron capture detectors, sample pretreatment, and preconcentration steps may also give rise to an alteration of sensitivity, and the chance for interference.

Table 34 provides a brief description of some of the analytical techniques which have been employed at various times by the subprograms of the NPMP. For comparative purposes, the table is arranged by environmental components, pesticide, organization, date reported, treatment, analysis, sensitivity, and percent recovery. The data in Table 35 provide a comparison of some of the variations in column and detector operational parameters noted for the indicated subprograms. A study of this table indicates that, for the analysis of chlorinated hydrocarbons, at least two GLC column supports, various column temperatures, and various GLC stationary phases have been utilized. Table 36 compares some of the sample treatments which have been employed by the indicated subprograms and shows similar variations for sample treatment. The data presented in these tables are not intended to be exhaustive, but rather are intended to give a general picture of the variations which have occurred in NPMP subprogram analytical procedures.

Individually, the analytical techniques which have been used by the NPMP subprograms are generally adequate and appear to have kept pace with advances in analytical methodology. Collectively, however, there are shortcomings with respect to directly correlating the analytical results within and across subprograms. This is due primarily to the variations in the techniques indicated in Tables 34-36. For instance, an examination of the tables indicates that there are at least six or seven different general extraction procedures. It is understood that different tissues and samples (i.e., fish versus water) require different sample preparation and initial extraction procedures. However, the final extraction and analytical procedures should be similar so that final results are comparable not only for a particular subprogram, but also between various environmental media monitored by the NPMP.

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TABLE 34. ANALYTICAL TECHNIQUES

Environmental Component	Pesticide	Organization	Date Reported	Treatment	Analysis	Sensitivity	Recovery
Food and Feed	Chlorinated Organic Pesticides	FDA	1969-1970	Hexane-Extraction at pH = 2.	G.L.C.;Electron Capture Detector	0.003PPM (Heptachlor Epoxide)	Depends on Individual Compounds
	Organic Phosphate Pesticides	"	"	1:1 hexane and benzene at pH = 7-8.	G.L.C.;Thermionic Detector	0.01PPM (Parathion)	"
	Herbicides	"	"	Chlorination and Ether pH = 2.	G.L.C.;Electron Capture or U.V. Spectroscopy	0.02(2,4-D)PPM 0.05(amitrole)PPM	"
	Carbamates	"	"	"	"	0.2PPM for carbaryl	"
	Bromide	"	"	----	----	0.5PPM for bromide	"
	Arsenic	"	"	----	Atomic Adsorption; or Polygraphic	0.1PPM for arsenic as arsenite	"
Human Tissue	Chlorinated Organic Pesticides	EPA	1970	Hexane-Extraction at pH = 2.	G.L.C.;Electron Capture Detector	0.003PPM (Heptachlor Epoxide)	Depends on Individual Compounds
Water	Chlorinated Hydrocarbons	EPA	1964-1968	15% Ethyl Ether and Hexane.	G.L.C.;Electron Capture Detector	0.001-0.002PPB except: chlordane 0.005PPB toxaphene 1.0PPB	Recovery 85-95%
	Organophosphorous	"	"	"	G.L.C.;Flame Photometric	0.01-0.025PPB	"
	Chlorinated Hydrocarbons	USGS	1968-1971	Extracted with redistilled Hexane.	G.L.C.;Electron Capture Detector	>0.005PPB chlordane 0.1PPB 0.5-1.0PPB for toxaphene	85-110% Recovery
	Organophorothioate	"	"	"	G.L.C.;Flame Photometric Detector	>0.01PPB	"
	Herbicides	"	"	Acidity & extract with redistilled ethyl ether chemically treated.	G.L.C.;Electron Capture Detector	>0.005PPB 0.02PPB for(2,4,5)	" (No corrections for recoveries)
	Herbicides and Pesticides (Chlorinated Hydrocarbons)	USGS	1973	Extract CH_2Cl_2 and then the CH_2Cl_2 with Hexane.	"	0.02-0.1PPB	----
Sediment	Herbicides and Pesticides (Chlorinated Hydrocarbons)	USGS	1973	Extract with 3:1 hexane-isopropanol mixture and remove isopropanol.	G.L.C.;Electron Capture Detector	>0.05PPB depending on interferences	----
Sediment & Water	Organophosphates	USGS & EPA	1973	Same as above depending on water and sediment.	G.L.C.;Flame Photometric Detector	----	----
Soils	Chlorinated Hydrocarbons and Organophosphates	USGS & EPA	1969	Extract with 3:1 Hexane-isopropanol mixture - cont.	G.L.C.;E.C.D.(Chlorinated Hydrocarbons) G.L.C.;F.P.D.(Organophosphates)	>0.01PPM	100% ± 10%
	Atrazine	"	"	Extract with 25ml of water and 300ml of methanol.	G.L.C.;Flame Photometric Detector	0.01PPM	100%
	2,4-D	"	"	Diethyl ether extraction of acidified soil	G.L.C.;Electron Capture Detector	0.01PPM	86%
	Arsenic	"	"	Acid digestion with HCC.	Atomic Adsorption	0.1PPM	70%
	Chlorinated Hydrocarbons	"	---	Extract with 3:1 Hexane isopropanol.	G.L.C.;Electron Capture Detector	0.002-0.03PPM except PCB,chlordane, toxaphene which are 0.05-0.1PPM	90-110%
	Organophosphorous	"	---	"	G.L.C.;Flame Photometric Detector	0.05-0.1PPM	"
Crops	Chlorinated Hydrocarbons	USGS & EPA	---	With <2% Fats,extracted with acetonitrile.	G.L.C.;Electron Capture Detector	0.002-0.03PPM except PCB, chlordane, toxaphene at 0.05-0.08 PPM	stalks & hay 80-95% grains 90-100%
	Organophosphorous	"	---	With >2% Fats,extract with isopropanol and Hexane.	G.L.C.;Flame Photometric Detector	0.05-0.0PPM	87.1% for soybeans 86.9% for sorghum grain 88.9% for corn stalks
Fish	Chlorinated Hydrocarbons	--	1967-1968	----	----	----	----
	"	[redacted]	"	Extract with petroleum ether and Na_2SO_4;then hexane extraction.	G.L.C.;Electron Capture Detector	>0.001PPM	----
	"	"	"	Hexane extraction with acetronitrile partitioning.	G.L.C.;Electron Capture Detector	"	----
	"	FDA	"	Extraction with acetonitrile,petroleum ether,and acetonitrile.	G.L.C.;Electron Capture Detector		
	"	"	"	Extracted with 10%(V/V) ethyl ether in petroleum ether,and hexane extraction next.	"	>0.01PPM	90% recovery

TABLE 34. (continued)

Environmental Component	Pesticide	Organization	Date Reported	Treatment	Analysis	Sensitivity	Recovery
	"	"	"	Extraction with petroleum ether;then with acetonitrile.	"	----	----
	"	BSFW	"	Extract with petroleum ether;then acetonitrile -hexane and so on.	"	0.002 to 0.01PPM	Dieldrin - 83 ± 5% DDE - 64 ± 3% TDE - 90 ± 5% DDT - 81 ± 5%
	"	FDA	"	Extract with 10% ethyl ether and 90% petroleum ether.	"	>0.1PPM	----
	Total Mercury	"	1969-1970	Digestion in sulfuric and nitric acid.	Flameless Atomic Adsorption	>0.05PPM	97.5%
	Methyl Mercury	"	"	Same as Modified Westoo Procedure.	G.L.C.;Electron Capture Detector	0.02PPM	----
	Total Mercury	"	"	Digestion in H_2SO_4 and HNO_3 along with hydrogen peroxide.	Flameless Atomic Adsorption	>0.1PPM	----
Fish(Estuarine)	Chlorinated Hydrocarbons	FDA	1965-1972	Extraction with petroleum in Soxhlet apparatus;then extracted with acetonitrite.	G.L.C.;Electron Capture Detector	>0.01PPM toxaphene-0.25PPM	DDE - 80-85% TDE - 92-95% DDT - 91-93%
Starlings	Chlorinated Hydrocarbons	FDA	1967-1968	Extracted with ethyl ether and petroleum ether (1:24).	"	0.003-0.01PPM	88-103%
	Total Mercury	BSFW	1970	Sulfuric and nitric acid digestion.	Flameless Atomic Adsorption	>0.05PPM	84-103%
	Total Lead	"	"	Combusting and acidification with hydrochloric acid.	Flame Atomic Adsorption	>0.1PPM	----
	Total Mercury	"	1971	Desiccated over P_2O_5 for 14 hours, and combust in oxygen.	Flameless Atomic Adsorption	0.01-1.0PPM	----
	Total Lead,Cadmium and Arsenic	"	"	Acid digestion in sulfuric and nitric acid.	Flame Atomic Adsorption	>0.1PPM for lead >0.05PPM for cadmium >0.01PPM for arsenic	----
	Chlorinated Hydrocarbons	"	1972	Soxhlet extraction with ethyl ether to petroleum ethyl(1:24).	G.L.C.;Electron Capture Detector	---	78-98%
Eagles	Chlorinated Hydrocarbons	BSFW	1964-1965	Soxhlet extraction with acetonitrite and clean-up.	G.L.C.;Electron Capture Detector	>0.05PPM	85-96%
	Chlorinated Hydrocarbons	"	1966-1968	Petroleum ether extraction;followed by acetonitrite and clean-up.	"	>0.05PPM	for eagles: 95-112% for all tissues: ~88%
Eagles and Ducks	Chlorinated Hydrocarbons	BSFW	1969-1970	Soxhlet extraction with acetonitrite and clean-up.	G.L.C.;Electron Capture Detector	>0.05PPM (<0.05PPM was considered trace)	77-95%
	PCB	"	"	"	"	1PPM	----
	Total Mercury	"	"	Oxidized with H_2SO_4-HNO_3 and H_2O_2.	Flameless Atomic Adsorption	>0.02PPM	90-107%
	Methyl Mercury	"	"	Extracted with methyl ethyl ether;3:1 mixture.	G.L.C.;Electron Capture Detector	---	61%
Mallards and Black Ducks	Chlorinated Hydrocarbons	BSFW	1965-1966	Extract with petroleum ether;then ethyl and petroleum ether.	G.L.C.;Electron Capture Detector	>0.05PPM	>84%
	"	"	1969-1970	Soxhlet extraction with (1:24)ethyl ether and petroleum ether; then hexane-acetonitrite extraction.	"	>0.02PPM	90-96%
	PCB	"	"	"	"	>0.03PPM	123%
	Total Mercury	"	"	Acid digestion with hydrogen peroxide.	Flameless Atomic Adsorption	>0.05PPM	97%

TABLE 35. COMPARISON OF COLUMN AND DETECTOR OPERATIONAL PARAMETERS FOR CHLORINATED HYDROCARBON PESTICIDES

Sample	Stationary Phase	Support	Column Temp	Detector	Carrier Gas and Flow
Water	3% DC-200 and 5% OV-210	Gas Chrom Q	205	Ni^{63}	N^2 at 100 ml/min
Soils	99% QF-1	Gas Chrom Q	166	Tritium Foil	5% CHa and Ar at 80 ml/min
Fish	3% DC-200	Gas Chrom Q	190	Tritium Foil	N_2 at 40 ml/min
Starlings	5% DC-200	Gas Chrom Q	200	Sr^{10} cr Ni^{63}	N_2 at 70-90 ml/min
Eagles	6% QF-1	Supelcoport	190	Ni^{63}	5% CHa and Ar at 60 ml/min
Ducks	3% OV-17	Gas Chrom Q	190	Sr^{90}	N_2 at 100 ml/min

TABLE 36. COMPARISON OF SAMPLE TREATMENT FOR CHLORINATED HYDROCARBON ANALYSES

Sample	Treatment	Sensitivity	Recovery Percent
Ducks	Extract with petroleum ether; then (1:2.4) ethyl and petroleum ether mixture	>0.02 ppm	80-96
Eagles	Soxhlet extraction with acetonitrile and clean up	>0.05 ppm	77-95
Starlings	Soxhlet extraction with (1:2.4) ethyl and petroleum ether mixture	>0.05 ppm	78-98
Soils	Extract with 3:1 hexane-isopropanol mixture	>0.01 ppm	85-100
Sediment	Extract with 3:1 hexane-isopropanol mixture	>0.05 ppm	85-100
Water	Extract with 10 percent (v/v) ethyl ether in petroleum ether; followed by hexane extraction	>0.01 ppm	90-100
Crops	Extract with acetonitrile and clean up	>0.02 ppm	80-100
Human Tissue	Extract with redistilled hexane	>0.003 ppm	80-100
Food and Feed	Extract with redistilled hexane	>0.003 ppm	80-100

CHAPTER 4. EFFECTIVENESS OF THE NPMP

INTRODUCTION

It has been amply demonstrated that pesticides affect natural systems in two ways: (1) direct effects - the use of a specific pesticide to limit or control specific pest organisms (Irving 1970); and (2) indirect effects - the accumulation or movement through time of a pesticide into environmental components other than those for which the pesticide was intended (Bailey et al 1974; Buffington 1974; Crawford and Donizian 1973). Direct effects are easily understood and represent the planned destruction or control of a pest species at a particular point in time and space. Indirect effects are not so obvious as they are a function of pesticide movement through environmental compartments per unit time. Thus, only when the functional relationships between compartments over time are established can one start to identify indirect pesticide effects.

The NPMP was structured to monitor environmental compartment/time relationships. This ambitious, multi-faceted program is charged with the following objectives:

(1) determine the ambient levels of pesticides, their residues and other major pollutants in selected environmental components: soil, air, water, estuaries, raw agricultural crops, food and feed, fish, wildlife, and humans.

(2) determine the changes in these levels over time.

(3) identification of problem areas.

There is some question with respect to the identification of problem areas as an objective of the NPMP. Henderson et al (1969) stated that,

> "The objectives of the National Pesticide Monitoring Program are: (1) a continuing nationwide assessment of the general levels of pesticide residues in the environment, and (2) the location of possible problem areas within specific segments of the environment."

> "Possible problem areas will be located where the survey data indicate the concentration of a pesticide has developed above the general level or where there is an increasing concentration over a period of time."

Henderson notes that these objectives were adopted by the FCPC Subcommittee on Pesticide Monitoring and accepted by the Federal Committee on Pest Control.

The identification of problem areas is also indicated as an objective of two of the functional elements of the NPMP. Feltz (1971) stated that one of the objectives of the water monitoring program is "to identify possible problem areas". Wiersma (1971) indicated that an objective of the soil monitoring program was "to provide a basis for initiation of special studies on demonstrated problem areas". In addition, the Panel on Pesticide Monitoring (1971), listed criteria which could be used to define pesticide levels to be considered as an alert to potential problems. The Panel also recommended that, "In accord with research advances, agencies should develop specific possible problem-area definitions for each medium being monitored".

In light of the above discussion, the identification of possible problem areas is considered to be within the purview of the NPMP. Thus, this aspect of NPMP operations, whether real or implied, is discussed in the assessment of the effectiveness of the NPMP.

To fulfill the objectives of the NPMP, both short- and long-term assessment of pesticide residue levels and trends are required. Such requirements dictate a comprehensive statistical approach.

Recognizing the complexity and diversity inherent within the NPMP, EPA charged BCL to (1) assess the quality of available NPMP data with respect to drawing statistical inferences on trends in national pesticide residue levels; and (2) to discuss the overall effectiveness of the NPMP in meeting its objectives.

It is important to recognize that data quality and amenability to statistical analysis are functions of adherence to a number of constraints. Some of the more important are the:

(1) Category being monitored. The interpretation of the data must be restricted to the portion of the environment which it represents. Though an ecosystems approach is desirable, it demands a correlation of sampling effort between categories. Statistical analysis and/or modeling demand equitable sampling efforts and only through a mathematical-biological data synthesis using appropriate transfer functions can the categories be interrelated.

(2) Adequacy of the experimental design. Experimental design is used as a means for controlling experimental error. This consists of designing an experiment so that natural variability associated with the experimental units is controlled, thereby contributing little to the differences between treatment means. A variety of designs are suited for measurement of each subprogram; however, samples from each environmental component must not only be representative of the populations from which they came, but should also lend themselves to a nationwide design capable of incorporating all subprograms. The best design to use is the simplest design available that gives the required precision and can incorporate all the environmental components being monitored. The design must be carefully chosen so that inferences can be legitimately extended to the population being sampled, and the ability of statistical analysis to detect true effects due to pesticides is maximized.

(3) Representativeness and availability of the experimental units. The correct choice of experimental units is also a means of controlling experimental error. The experimental unit or units within each category must be statistically and biologically representative of that category and of sufficient abundance to supply an adequate sample size. Where appropriate, size,

trophic level, age, race, health, location, sex, and time must be taken into consideration. The optimum sampling frequency required to determine pesticide levels and changes over time for each category depends on the variability of pesticide use and the environmental component being monitored.

(4) Consistency of experimental design, experimental units, and sampling techniques. Frequent design changes are particularly undesirable in a national program as the very nature of the change introduces variability not associated with the treatment. Consistency here places control over known or potential influencing factors and helps prevent bias. Inconsistency may mask real changes in trends by giving erroneous results, thus precluding long-term trend analysis. For example, different experimental units have different inherent variabilities. Therefore, by changing from one unit to another over time, the variability due to pesticide treatments changes. In this case results from statistical analysis can no longer predict levels or trends over time. Additionally, a change in one subprogram may bring about an unwanted but necessary change in another.

The consistency of sampling techniques must be such that no bias is introduced affecting the values of the treatment means. Inconsistency may increase experimental error through random or nonrandom effects. These effects may not be immediately apparent, but can be detected with appropriate statistical tests.

(5) Design fulfillment. Failure to follow the established design is mathematically unacceptable. In each case, good statistical assessment depends on how successful each investigator is in following the experimental design. Good fulfillment assures proper sample size

as well as reliability and ease in analysis. Although the absence of some data can be handled statistically, it too should be avoided. Reliability increases with completeness.

(6) Sufficiency of the data. There must be enough replication to stabilize the variance. For an effort such as the NPMP, broad inferences are to be made over time and space. Replication over time allows estimates of treatment means to become more precise, thus increasing predictive capabilities. The number of replicates needed is determined by a number of factors including the degree of precision required, the type and number of treatments, the experimental unit being measured, and the experimental design.

(7) Sensitivity and accuracy of analytical techniques. As in sampling, analytical techniques must be standardized and free from bias. Increased sensitivity means increased ability to detect levels and trends. If the intent is to determine whether or not pesticide residues are present (a qualitative approach), then improved techniques have little effect. However, if, as with the NPMP, concern lies not only with detection of pesticides but with types and levels (a quantitative approach), then changes in analytical techniques become critical factors in statistical trend analysis. Also, differential abilities to detect particular pesticides makes a difference in the quantitative residue levels reported.

(8) Time and money. Time and money may be the ultimate constraints. However, all efforts should be made to provide sampling which is uninterrupted, and as comprehensive as possible, within these constraints.

Since there is no overall NPMP experimental design, each subprogram is assessed separately. The aforementioned constraints, the defined objectives of the NPMP, and accepted statistical methodology served as the basis for evaluation.

DISCUSSION OF SUBPROGRAMS

Monitoring Residues in Food and Feed

Market Basket

Since its initiation in FY 1965, the experimental design for this element of the food and feed subprogram has undergone several significant changes. Originally 82 food items were sampled bimonthly in each of three FDA regions. Two Food and Drug Administration (FDA) regions were added in FY 1966 to allow for a more nationally oriented sampling design. Beginning in FY 1969 the number of food items sampled rose from 82 to 117; this update was made to better reflect a normal diet (Table 1). In FY 1972, 35 market basket samples (not 30 as in other years) were taken. These changes should provide no problems statistically. Since that time, however, it became obvious that sampling was not taking place in some geographic regions such as the Northwest or Southeast. Consequently, in FY 1973 the sampling scheme was changed to cover all ten FDA regions, and residue levels are now reported through the Consumer Specialist Offices within 18 of the 19 FDA districts (Table 2). Only now is there a truly national coverage.

Sampling today is continuous. Each market basket is made up of 117 food items representing the two week diet of a 16-19 year old male (statistically the largest eater). Samples are taken from month to month by different Consumer Specialist Offices. Replicate market basket samples are taken in some regions in order to meet the annual quota of 30. These nationwide purchases are made in retail groceries in cities representing a standard metropolitan statistical area and those representing populations under 50,000. Where all 117 food items cannot be purchased at a particular grocery, the purchase is completed at a nearby store. Both the retail outlets and cities sampled change each sampling period within and across regions (Corneliussen, personal communication).

The method of selecting sampling sites could not be determined. If these cities and retail outlets are randomly sampled and therefore truly representative of all retail markets, then there appears to be no problem with the current design. If the sites are not randomly selected, the data will not meet the assumptions underlying analysis of variance, and thus will not truly represent the population being sampled. Table 37 indicates the changes in sample size and locations that have taken place over time. The new design must remain consistent in order to meet the objectives of the NPMP.

TABLE 37. MONITORING RESIDUES IN FOOD AND FEED--DESIGN CHANGES OVER TIME

Fiscal Year	No. of FDA Regions (R) or Districts (D) Sampled	No. of Cities Sampled	No. of Market Baskets Analyzed	No. of Food Items Sampled/Market Basket
1966	3R	(a)	18	82
1966	5R	25	26	82
1967	5R	29	30	82
1968	5R	27	30	82
1969	5R	24	30	117
1970	5R	28	30	117
1971	5R	27	30	117
1972	5R	(a)	35	117
1973	18D	30	30	117

(a) Information not available.

Samples have been continually obtained from consumer markets. The fact that some items not available at the original market must be purchased from nearby markets is not significant; that the sample is indeed representative and complete is the important consideration.

Although the experimental design has been changing over time, design fulfillment remained good. However, the continual changes in analytical methodologies and chemicals monitored, and the change to a truly national design in FY 1973 preclude accurate assessment of national levels and trends until more data are available. Considering each market basket as an experimental unit, sample sizes are very limited and frequency of incidence type data (percent positive composites) used for regression and prediction would not be desirable. Using mean or individual pesticide levels in food items, food classes, or per basket would provide more reliable estimates of levels, trends, and differences in rate changes between pesticide residue levels. Identifying problem areas is dependent on expediency in analysis and compilation of data.

ANOVA can be expected to measure variation across or within factors such as geographic regions, food classes, years, and pesticides. After significant differences are found, blocking on one or more factors may serve to increase the efficiency of the analysis and provide more information. For example, in assessing national residue levels with repeated measures over time, regional data would probably be pooled and blocked with respect to food class. Using the raw residue data for individual pesticides would provide the most sensitive analysis.

Assuming consistency in design, sampling, and analytical techniques a regression analysis should be used for prediction. Pesticide residue could be plotted as a function of time or use rate considering food classes within a pesticide or both food classes and selected pesticides. Rate change comparisons between individual pesticides could also be made.

Surveillance Program

The original design initiated in FY 1964, specified sampling at all major growing, processing, and marketing centers on a destination basis. Locations were selected randomly from wholesale markets and warehouses located in 85 cities.

As of FY 1971, the design is statistically sound as this subprogram was redesigned to monitor commodities on a geographic, point-of-origin basis. Each of the FDA field districts samples major food and feed items produced within their area; however, it could not be determined whether or how sampling sites have changed over time. Animal food ready for consumption is also included in this part of the program. As explained by Duggan and Cook, 1971,

> It can be used on a local or District Basis (1) to gather intelligence about a crop as a whole by taking one sample from each of 12 growers, (2) to evaluate a grower by taking one sample from each of 12 available lots of the same commodity, and (3) to evaluate one orchard (or field) by taking 12 samples at random through the area; or it can be used nationally (1) to compare the results on a product from several regions of the country, (2) to evaluate the results on a national basis, and (3) to compare the results with previous years to determine or discern trends.
>
> The sampling plan has been designed to allow statistical estimates of the incidence of residues in the population to be made with a 95 percent confidence that the sample estimate will be within ±2-5 percent (depending upon the actual incidence and number of samples examined) of the population parameter.

To establish these specific confidence intervals the inherent pesticide residue variability for the different commodities sampled had to be known. It is expected that 10,000-12,000 samples will be taken each year.

Sampling has generally followed the established design. Data reported in Table 4 are a summary of 5 years of surveillance activities. The Table notes missing data and/or lack of coverage. Some changes in the commodities sampled have occurred over time; these involve the grain, meat, and poultry groups. Sample size also varies over time; but due to the large numbers, this should cause no problem statistically. A yearly breakdown of residue levels is available in the Pesticide Monitoring Journal, Volumes 5 and 2, Numbers 2 and 1, respectively. No data have been made available to BCL beyond FY 1969. To satisfy the need for immediate assessment of possible increasing levels in pesticide residues, such data must be made available for analysis.

If the rigid sampling schedule is adhered to and the sampling is truly random, there should be no problem in obtaining the correct number and type of experimental units. Availability of experimental units should be satisfactory with point-of-origin sampling as well as giving a more representative cross check of foods in general. A tabulation of the major growing, processing, and marketing centers sampled should be made available as it is important to monitor changes in sampling sites as well as pesticide residues.

Except for the non-availability of more recent data, that which is available can be statistically analyzed. The potential methods of statistical analysis would follow that of the market basket subcategory, but in this case, commodity groups would replace food classes as a source of variation. Differences might be determined between domestic and imported food and feeds. Whether there is a statistical difference between point-of-origin or destination sampling can also be assessed.

Duggan et al (1971) have completed some preliminary regression and chi-square analysis with these data to assess levels and trends. As he observed,

> The frequency of occurrence, as well as the sensitivity of the method for a specific pesticide chemical, must be considered in attaching significance to the calculated daily intake. Where a method is relatively insensitive, a few positive findings will unduly influence the calculated value, even though the frequency of positive findings does not justify recognition as a common component in the dietary intake of pesticide chemicals.

The addition of more recent data can only improve the accuracy of trends being monitored.

Meat and Poultry Inspection Program

This subprogram has been continuously monitoring residues for several decades. Serious efforts at data compilation for meat and poultry as a separate entity began in 1965 for meat and 1968 for poultry. Today, inspection takes place at 5763 meat and poultry slaughter houses across the the country. The actual locations of these plants have not been made available to BCL and the method of site selection is unknown.

The stated purpose of this monitoring effort is to determine the incidence of a given residue in the total population and in locating problem herds and flocks (USDA 1973). As such, this is primarily a regulatory operation aimed at keeping violative residue levels in meat and poultry from reaching the nation's markets. Reported data is very erratic in chemicals monitored, sample sizes, and years reported (Table 5). The data reported by the Surveillance Program for meat and poultry are more in line with NPMP objectives. The same data are often reported for both subprograms. The meat and poultry inspection as a regulatory device cannot be considered part of the NPMP for statistical purposes. Statistically reliable data are available through the Surveillance Program as has been discussed under that subtopic.

Monitoring Residues in Humans

This category has been continually updated since its initiation in 1967. Until FY 1970 no experimental design was used; samples were taken on a calendar year basis by pathologists selected nationwide (Yobs 1971). There was no apparent statistical basis for the selection procedure.

In 1970 it was determined that, in order to get statistically reliable data, an overall design was needed. The contiguous 48 states were divided into four census regions. At that time, the sample size and distribution were based on the 1960 census figures. A total of 50 sample sites were randomly selected to provide 1950 individual samples each year. Beginning in FY 1972 the design was further updated. Kutz (personal communication) described the statistical justification for this change:

> After three years of operating under this design, the program was evaluated and several problems cited. The greatest problems encountered were nonresponse and the inability of pathologists to fill their assigned quotas of 50 samples.
>
> Now that a new census has been taken and preliminary reports are available, the Monitoring Program should be redesigned according to local instead of national proportions. A review of past survey data yielded valuable information in planning the 1972 design. Fewer specimens will be collected from each pathologist, allowing more pathologists to participate. To obtain a greater geographical spread sampling will be from nine census divisions instead of the four census regions.
>
> The goal is to measure the population mean residue levels in adipose for chlorinated hydrocarbon pesticides. From previously collected data it is known that the largest amount of residue, pp'DDE, had a mean value of 3.98 with a standard deviation of 3.97. Using this information, one can select the sample size needed to measure the population mean with a desired margin of error. Given a 95 percent confidence level, a sample size of 3,000 should be adequate to measure the mean of pp'DDE with a margin of error of less than 4 percent. This sample size should therefore be sufficient to measure the mean levels of the other related hydrocarbon pesticides.
>
> From past experience it is estimated that 40 is a practical number of specimens that can be collected annually from each sampling site. Consequently, 75 sampling sites will yield the desired 3,000 specimens.

The current design calls for 27 samples of human adipose tissue to be taken at 75 randomly-selected sites. This number was determined to be the lowest possible in order to give statistically valid results (Strassman personal communication). The Nation was first stratified into nine census regions. Sample sites were allotted to each census region based on its population distribution: New England, 6 percent; Middle Atlantic, 18 percent;

East North Central, 20 percent; West North Central, 8 percent; South Atlantic, 15 percent; East South Central, 6 percent; West South Central, 10 percent; Mountain, 4 percent; and Pacific, 13 percent. Cities with populations of more than 25,000 were randomly selected within each region (Figure 4). Pathologists from both general and childrens' hospitals are selected to fill population parameter quotas.

Individual hospitals were selected on a systematic basis. Criteria for selection include the number of beds, number of admissions per year, facilities (research-oriented hospitals preferred), population of the area served by the hospital, and the demographic distribution of age and race groups (Strassman personal communication).

Certain larger metropolitan areas contain more than one sample site (Table 8). Samples proportionate to census figures within each region on sex, age (14 years and under, 15 through 49 years, and 50 years and over), and race (white and nonwhite) are taken from postmortem and surgical specimens yearly (Table 7). Spencer (1974) notes, "An effort is made to exclude samples from cases of known or suspected acute pesticide poisoning, or chronic debilitating illness, and from patients who have been institutionalized for long periods." If selected pathologists cannot meet their quotas, another pathologist in the same city may be contacted to complete the quota. Alternate cities within each region may be sampled if it is clear that quotas cannot be met in the originally selected city.

Human adipose tissue is a known accumulator of and exposure indicator for chlorinated hydrocarbon pesticides. The body stores these chemicals for long periods of time. There are, however, inherent difficulties in obtaining samples of this experimental unit. Availability is dependent on chance and it has been found that adipose tissue from children 14 years of age and under have been particularly difficult to obtain. Even though many children's hospitals are currently used as sample sites, some cities have no such facility. As noted above, some flexibility in sampling cities is allowed. The design must be adhered to as closely as possible, however, in order to produce statistically valid results. In the past pathologists have been paid for supplying tissue samples beyond their quotas. This explains the very large sample sizes from some cities (Table 8). This practice is being corrected (Strassman personal communication).

This category of the NPMP is unique in that sample collection is complicated by the fact that the program must follow the ethical guidelines set forth by the Department of Health, Education, and Welfare for the protection of human subjects. Thus, acquisition of samples is dependent on both the availability and cooperation of human subjects. Hence, missing data can be expected. The strength of any statistical analysis and the inferences made from it will be a function of the success each pathologist has in filling his quota through unbiased sampling.

Table 38 indicates design fulfillment for the FY 1970 and FY 1971. Sample size is erratic for these early years and no real trend toward improvement is apparent. Data for FY 1972 and FY 1973 are not available, but since the sample site quotas were lowered to 27 in FY 1973 design fulfillment through time is expected to improve.

Assuming that adipose samples are readily and consistently available, this design should provide a good comprehensive data base amenable to statistical analysis. Variation can be measured at the national, regional, state, city, or pesticide level. Further breakdown to age, sex, and race parameters may be possible depending on sample size and inherent variability. Although data are stratified by census region, they can be analyzed on the basis of other characteristics such as pesticide use rate patterns.

These data should fit a number of statistical designs. Expected residue level variation might be controlled through blocking the data on regional or land use characteristics. Differences between age, sex, and/or race factors can be assessed. Correlation or multiple correlation analysis will indicate relationships between different ages, age classes, sex, race, city, state, region, or any combination thereof.

However, according to Kutz (personal communication) FY 1972 and FY 1973 data do not appear "good". Generally, younger age groups were under-represented while older groups and blacks were over-represented. On the other hand, some areas of the country are not able to supply their blacks quotas. Design refinement over time has improved the data base, but unless 1972 and 1973 data can be salvaged statistically, more data will be needed before trend assessment can begin.

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TABLE 38. MONITORING RESIDUES IN HUMANS--DESIGN FULFILLMENT FOR FY 1970 AND 1971

Key: Divison Region State City	No. of Samples Called For by Design	Actual No. of Samples Taken 1970	1971	Percent Fulfillment 1970	1971	Percent Change
NORTH EAST						
New England						
Massachusetts						
Fitchburg	50	31	51	62	102	40[a]
Leominster	50	15	9	30	18	-12
Middle Atlantic						
New Jersey						
Ridgewood	50	31	23	62	46	-16
New York						
Binghamton	50	37	137	74	274	200[a]
New York City	150	158	194	105	129	24[a]
New Rochelle	50	54	46	108	92	-16
Pennsylvania						
Philadelphia	50	38	27	76	54	-22
Pittsburgh	50	22	24	44	48	4
NORTH CENTRAL						
East North Central						
Illinois						
Beleville	50	25	34	50	68	18
Chicago	100	70	69	70	69	-1
Oak Lawn	50	70	78	140	156	16[a]
Michigan						
Detroit	50	47	66	94	132	38[a]
Ohio						
Lorain	50	61	66	122	132	10[a]
West North Central						
Iowa						
Des Moines	50	0	17	0	34	34
Kansas						
Salina	50	87	45	174	90	-84
Witchita	50	5	7	10	14	4
Minnesota						
Minneapolis	50	34	0	68	0	-68
Missouri						
St. Louis	50	17	81	34	162	-130[a]
South Dakota						
Souix Falls	50	47	29	94	58	-36
SOUTH						
South Atlantic						
District of Columbia	50	21	8	42	16	-26
Florida						
Miami	50	0	3	0	6	6
Miami Beach	50	94	34	184	68	-116
Georgia						
Atlanta	50	65	128	130	256	126[a]
East South Central						
Kentucky						
Owensboro	50	44	30	88	60	-18
Tennessee						
Memphis	50	157	242	314	482	168[a]
Louisiana						
New Orleans	50	41	90	82	180	98[a]
Oklahoma						
Oklahoma City	50	31	16	62	32	-30
Texas						
Houston	50	0	31	0	62	62
WEST						
Mountain						
Arizona						
Tuscon	50	28	30	56	60	4
Pacific						
California						
Loma Linda	50	42	70	84	140	56[a]
Los Angeles	50	45	0	90	0	-90
San Diego	50	50	43	100	86	-14
Stanford	50	31	50	62	100	38[a]
Oregon						
Portland	50	54	12	108	24	-84

(a) At or above 100 percent fulfillment

Source: Strassman, personal communication (1974).

Monitoring Residues in Soils

Cropland and Noncropland Areas

A truely national soils monitoring program was not initiated until FY 1969. Many feasibility studies predated the current design but cannot be considered as part of the NPMP. The more siginficant studies will be discussed here with no assessment being made of the specifics of each design.

From 1965 through 1967 sampling occurred in six study areas ; and pesticide residue levels in soil, water, sediment, and terrestrial and aquatic organisms were reported. This USDA directed study was an ambitious effort to correlate various environmental components through an ecosystem approach. It was intended as a three-year study, but its statistical soundness was severely reduced by design changes over time (Table 9). Pesticide use records for each area were also determined for correlation with residue data.

Running concurrent with the monitoring in six study areas was another USDA pilot study being conducted at 51 nationwide locations. It was designed to determine existing pesticide residues in soils from 17 areas in which pesticides were used regularly, 16 areas with a record of at least one pesticide application, and 18 areas with no history of pesticide use (Table 10). Application records were also determined for these regular, limited, and no-use areas.

In 1967 the USDA initiated a preliminary study in six states based on a newly-formulated national design. Sampling occurred on both cropland and noncropland ; and, again, pesticide use information was obtained for each sampling site (Table 11).

In FY 1969 the national program went into full-scale operation. The design was based on the Conservation Needs Inventory (CNI) Survey design used by the Soil Conservation Service. The most comprehensive description of the design for this program was given by Wiersma et al (1971).

> Soils of the conterminous United States are designated in one or the other of two land-use categories:
>
> Cropland - Includes land in corn, wheat, other grain, soybeans, hay, vegetables, and potatoes, orchards, sugarbeets, and sugar cane, tobacco, cotton, and other crops. This area covers about 400 million acres.
>
> Noncropland - Includes woodland, pastures, grazing, land, and all other lands not defined as cropland. This area covers about 1-1/2 billion acres.
>
> Sample sites for the monitoring program were selected from the sample segments used in the CNI. These segments are based on a stratified random design with an average sampling density of about 2 percent of each land-use category, although variation in sampling rates occur. The CNI segments are generally 100 or 160 acres in size, but some are 40, 400, or 640 acres. Land-use and other information is reported at 18 to 25 points within the 100-acre segments with proportionately more for 160-acre setments.
>
> In the soil monitoring program, cropland is sampled at 0.025 percent or one 10-acre block for every 40,000 acres of cropland. This provides for 9,468 cropland sample sites. Noncropland will be sampled at a rate of 0.0025 percent or one-tenth of that for cropland. This provides for 3,832 noncropland sample sites.
>
> A random method of selecting sample segments from the CNI was devised. A method of selecting a 10-acre site within the CNI segment was applied with the aid of data available for points within the segment. Two points are selected about which a 10-acre sampling site is located for the soil monitoring program.
>
> ...After two points are selected, a designation is made on an aerial photo or other map of a 10-acre site with these points centrally located. Attention is given to making boundaries conform with natural physical features such as
>
> (a) boundaries between cropland and noncropland (as defined)
> (b) roads and railroads
> (c) hedgerows, stone fences, etc.
> (d) streams, brooks, rivers, runs, creeks, etc.
>
> Records will be prepared so that the site can be defined and readily located with the same boundaries for subsequent samplings at 4-year intervals. A well-documented map or sketch of the location will be recorded. In addition to the guidelines already enumerated, the location will contain no less than 8 acres of available land.

The distribution of sampling sites by state and land-use category is shown in Table 12. The sampling schedule indicates:

> One-fourth of the sites in each state (selected in a random manner) will be sampled each year. Each site will probably be sampled a minimum of three times at 4-year intervals. On crop-

> land, soil and crop samples will be taken at harvest. Initial soil samples from noncropland can be taken any time during the year; however, subsequent sampling of all locations will be accomplished at approximately the same time of the year the first sample was taken.

Soil samples are taken according to the following design:

> Data collected at the time of sampling and every year between sampling periods include: (1) kinds and amounts of pesticides applied per acre; (2) formulation of pesticides applied and method of application; (3) crop grown on the land; and (4) the number of acre-inches of water applied if land is irrigated. A general history of pesticide use prior to the initial sampling is obtained as far back as possible for each site.

Additionally,

> A predetermined number of water and sediment samples will be collected after the sites for soil sampling are established. Samples of corn, sorghum, soybeans, cotton, hay, and forage will be collected (when available) from the soil sampling sites.

Crop data are available for FY 1969 and FY 1970 only. The 1969 data are unpublished and in an old data format while the 1970 data have been published and appear in summary form with the soils data. The differences in format made the compilation of a standard table impossible (Tables 15 and 16). No further assessment can be made other than the observation that the remaining crop data must be made available for any soil/crop statistical inferences to be made.

Data from the earlier feasibility studies on soils cannot be used for assessment of long-term trends in pesticide residues. They were neither of long enough duration nor of broad enough scope. Within the geographic areas sampled by these studies, pesticidal problem areas, if any, could be determined. This, however, is no longer of any use.

Under the new design, sufficient data should exist to identify problem areas in soils and crops in cropland areas. No assessment can be made of noncropland soils except for the few areas sampled in FY 1969.

The cropland and pesticide use rate data generated by the current design are reported by site, state, and cropping region. As noted by Crockett et al (1970) these data are not normally distributed. Transformations to normality would be appropriate before any analysis of variance, regression, or correlation tests are performed.

Inherent variability across and within soil types would tend to make any type of statistical analysis suspect. Taking a large number of soil cores in each 10-acre sample site, however, should account for most of this variability.

A split plot type analysis might yield the most information by making detectable small differences on a site-to-site, subplot comparison. Analysis should also be performed between pesticide levels among or within crops as an indication of inherent abilities to store pesticides. For comparisons of residue levels across cropping regions, soil cores can be composited. Analysis of the variabilities within sample sites would also be appropriate using individual core samples. Using both use rate and residue data, regression analysis is possible across cropping regions or individual sites.

Sampling apparently occurs at some sites from year-to-year; thus, comparisons can be made on this basis. Nationwide trends in levels, however, can only be detected after several 4-year cycles are complete. Given the nature of the NPMP with its frequent component design changes and erratic funding, this ambitious effort of continuing 4-year cycles in the soils program may be unrealistic. Efforts at meeting this design's requirements, however, have been good.

Since the initiation of this design, the soils program has been plagued with inconsistencies. Special studies in FY 1969 included determination of pesticide residues on a local level for wheat, tobacco, onions, and sweet potatoes. After FY 1969 the noncropland category was dropped from the program for an indefinite period. The second year of cropland sampling occurred as scheduled in FY 1970. Due to inadequate funds in FY 1971, nationwide sampling did not occur. A variety of special studies were performed including studies in the cotton and corn belts; studies on peanuts, vegetables and orchards, hay feedlots, mercury and soil, and sugarbeets; and a soil/rodent correlation study. The 4-year cycle was completed with FY 1972 and 1973 sampling. Beginning in FY 1974 a the second 4-year cycle began in cropland areas.

Changes in sampling procedures over the earlier years were due to improving methodologies. Since the initiation of the nationwide program, procedures have been consistent with consideration being given to factors such as varying soil profiles and the potential for contamination.

A discussion of design fulfillment for the many earlier feasibility studies would not be relevant to assessment of the NPMP. Design fulfillment for the new design is shown in Table 39. Percent coverage for the noncropland areas in 1969 was very low. Considering the scope of the cropland design, coverage for these areas has been good. Lack of sampling in some areas simply limits the type and quality of statistical inferences that can be made about those areas.

TABLE 39. MONITORING RESIDUES IN SOIL--DESIGN FULFILLMENT FOR FY 1969-1974

Fiscal Year	Land-Use Characteristic	No. of Samples Called For By Design	Actual No. of Samples Taken	Percent	No. of States Sampled	Percent
1969	Cropland	2,367	1,729	73.0	43	89.6
	Noncropland(a)	958	199	20.7	11	22.6
1970	Cropland	2,367	1,506	63.6	35	72.9
1971	Only special studies conducted					
1972	Cropland	2,367	1,486	62.8	34	70.8
1973	Cropland	2,367	1,476	62.4	36	72.0
1974	Cropland	2,367	1,442	60.9	36	72.0

(a) Noncropland category dropped after FY 1969.

Some missing data can be accounted for statistically when determining trends. This is not true for identification of problem areas. Due to the high variability in cropping regions and soil types, percent design fulfillment is directly related to the effectiveness of statistical identification of problem areas. When limited funds are diverted to special studies as in FY 1971, valuable data are lost and the sampling frequency is disrupted. Limited nationwide data are more beneficial to trend analysis than no data at all.

There appears to be much potential in correlating soil and crop data over the years. With use-rate data being collected concurrently with soil and crop data, pesticide transfer relationships between soils and crops might be established given the availability of necessary basic research backup. This potential could be further enhanced with water and sediment data that, according to the current design, are to be collected. However, this apparently is not now being done.

Urban Areas

In FY 1970 a pilot study was undertaken to determine pesticide residues in urban areas. Sampling in these areas took place in fifty 50 x 50-foot randomly-selected plots within selected cities. Sixteen core samples were taken from each plot and blended into one sample for residue analysis. Samples were taken in "lawn and waste" areas. Beginning in FY 1973 sampling of soils within city limits and in suburban areas was initiated.

Eight cities were sampled during FY 1970 and this subprogram has continued with 14 cities sampled in FY 1971 and five cities in each of FY 1972, 1974, and 1975. There has been no consistency in sampling the same cities from year to year (Tables 17-20).

Since FY 1972, statistical considerations have been used in selecting urban areas to be sampled. Each year five cities are randomly selected from the nation's Standard Metropolitan Statistical Areas (SMSA's). One city from an area over 1,000,000 population, three cities from areas between 100,000 and 1,000,000 and one from an area less than 100,000 make up the five cities sampled. It is planned to begin repeated sampling of previously sampled urban areas in FY 1976 (Carey personal communication).

Statistical analysis for urban areas should take differential land use characteristics into consideration. Differences between lawns, gardens, vacant lots, city and suburban areas, etc. can be analyzed. Trend analysis is possible only if the same cities are sampled from year to year. Even if repeated sampling occurs as planned, nationwide urban area trend analysis from the resultant data may be misleading, because there is no assurance that five areas is a large enough sample size. Repeated sampling, however, will help determine an adequate sample size. Given good data over time, correlation between pesticide use rates in surrounding cropland and noncropland areas and residues in urban soils might be possible.

Monitoring Residues in Water

The monitoring of pesticides in water has occurred since the 1950's. Due to unavailability of information, however, our statistical assessment begins with the year 1964.

Monitoring of surface waters was under control of the Federal Water Quality Administration (FWQA) from 1964 to 1968. The design called for nationwide sampling at 100 locations in nine geographic regions. Sampling was conducted during September, 1964-1967, and in June, 1968 (Table 22). Beginning in October, 1967, (water year 1968) monitoring was restricted to 20 western streams under control of the United States Geological Survey (USGS). Samples were taken monthly. In water year 1972 more western streams were added and many of the original 20 were changed. Sampling frequency was also changed to quarterly collections. Sediment samples were taken on a semi-annual basis. Monitoring on these streams continued until the end of FY 1974. In 1973, a nationwide pilot study was conducted based on a design by Feltz et al (1971).

This subprogram is now under a new design initiated in FY 1975. Water samples are to be taken at 153 nationwide sampling stations during the summer, fall, spring, and winter. These stations are generally compatible with the odd numbered USGS National Water Data Nework sites (Figure 5). One water sample is a composite of subsamples taken from three points and a series of depths at each station. Sediment samples are to be taken twice each year (Manigold personal communication).

As discussed by Feltz et al (1971),

> The optimum sampling frequency required to define pesticide levels in the waters of the Nation depends on the variability in pesticide concentrations throughout the year. In a statistical sense, there is no answer to the question of how many samples are needed over the period of a year without foreknowledge of the variability in concentration of the pesticides being measured. Thus, a rather arbitrary frequency must be set initially, and adjusted at a later date after sufficient data have been evaluated.
>
> Because of very limited manpower and funds, the number of samples collected must be held to a minimum. Thus, it is imperative that sampling be conducted at periods that will yield the greatest amount of information.

He continues by noting,

> Since most pesticides are introduced into the hydrologic system between early spring and late summer, highest levels in the bottom sediment might ordinarily be expected several months later. A majority of streams are at low flow during October

> and November; hence, most of the erosion products transported during and immediately following the pesticide application season would be deposited in the stream beds by this time. Relatively little of this material would have had an opportunity to pass from subbasins to coastal waters.
>
> In April and May the majority of streams are at high flow, transporting a near maximum suspended sediment load just prior to the pesticide application season. Results might be indicative of the residual effect of the previous year's (or years') application(s) of pesticides.
>
> Based upon these hypotheses, it is recommended that as a minimal program, water samples be collected at all stations four times a year - the first weeks of November, February, May, and August. An annual mean of the pesticide level at each station can thus be obtained. Collection schedules may be adjusted slightly to be compatible with a regularly scheduled visit to the accounting stations. A bottom sediment sample should be collected at each station concurrent with the November and May sampling.
>
> As soon as sufficient data are available from this program, and periodically thereafter, an assessment should be made of the number of stations, the pesticides being identified, and the sampling frequency so that adjustments can be made as necessary to maintain an effective program.

USGS is to perform about 90 percent of the sampling and the EPA 100 percent of the analysis. Residue analysis is to be performed on the suspended solids and the filtered water separately; these two are then combined for the "whole water" totals (Feltz and Manigold, personal communication).

Over the years these has been little consistency between sampling frequency and residue analysis made. As an example, Schulze et al (1973) note:

> From January to June, 1970, samples were analyzed quarterly for the phosphorus insecticides - methyl parathion, parathion, and diazinon. Beginning in July, 1970, the samples were analyzed monthly for these compounds and also for malathion. Beginning in October, 1969, the samples were analyzed routinely for polychlorinated biphenyl (PCB's) compounds.

From 1964 to 1968 analysis was performed on whole water samples (water plus any suspended solids). Beginning in 1972 water was filtered of suspended sediments and both components were analyzed separately. Analyses were combined for whole water totals. Also in 1972, sampling procedure changed; instead of depth integrated samples taken with one bottle, subsampling with several bottles was initiated. The method used for selecting sediment samples is unknown (Manigold personal communication).

The past data produced by the FWQA and USGS are neither of sufficient quantity or quality to be considered as part of the NPMP. Trend assessment within each block of time (1964-1968, 1968-1971, and 1972-1974) and in each region monitored is not feasible due to the short time periods. Problem area identification, although feasible for these early years, is no longer valuable as an alert mechanism.

The 1973 nationwide pilot study is also of no use statistically. Feltz (personal communication) described the year as a "total washout" and indicated that it was primarily a learning year for sampling and analytical methodology.

The present nationwide sampling program has been delayed as sampling equipment was still being obtained during the first quarter of FY 1975. It is expected that only three of the four sampling periods will be covered this year (Manigold personal communication). No statistical assessment of data can be made at this time. However, assuming the sampling stations are a random sample stratified on the basis of geographic region, land use, or drainage system, this design should provide a comprehensive data base.

Some critical factors to be taken into account by an ANOVA would be geographic region, drainage systems, land use criteria, and individual rivers. As data become available, tests for differences and or correlations between residue levels in suspended solids, filtered water, and sediment should prove valuable. This will provide an assessment of how residue levels in the fractional parts of each sample vary with the levels in each of the other fractions. Correlations can also be performed between up and downstream stations on the same river system. This will give an indication as to how upstream residue levels might ultimately affect downstream ecosystems.

The new program is quite comprehensive. It should provide for immediate identification of pesticidal problem areas particularly if correlated with use records and fish monitoring data. Long-term trend assessment will be possible only if the current design produces good data and remains in effect for at least four years.

Monitoring Residues in Wildlife

Bald and Golden Eagles

Since its initiation in 1964, there has been no experimental design for this category. As a top carnivore the eagle is a good experimental unit representing wildlife's upper trophic level. However, due to the protected status of this species, sampling is restricted to dead or dying specimens. Although samples are "randomly found" with time and location recorded, they are not representative of the entire eagle population. Fitting eagles into a broad national monitoring network would be difficult and also potentially very misleading. A problem also exists with those eagles found dead or dying from pesticide poisoning. Although the existence of these cases should be recorded, they cannot be considered typical and must be eliminated from the sample. If not, these eagles would tend to load the system with high residue levels thus causing erroneous conclusions to be drawn from the data.

With the exception of golden eagles having been sampled along with bald eagles in 1964 and 1965, the experimental units and sampling efforts have remained consistent. However, sample size is very low and replication statewide, regionwide, or nationwide is erratic at best (Table 24).

Descriptive statistics appear to be the only acceptable analytical approach here. Intrastate variability might be determined and extrapolated to the state's eagle population. Sample size, however, will be prohibitive. Any attempts at a regional or national type analysis would be unsound.

Results generated by this subprogram are valuable from a general information point of view but not for a national monitoring network; the reliability of any attempted trend analysis would be highly suspect.

Estuarine Finfish and Shellfish

From 1965 through 1972 duplicate samples of 15 mature mollusks were taken at about 30-day intervals from approximately 169 estuarine sites in 15 coastal states. About 10 percent of the duplicate samples were used as analytical cross checks; the remainder were discarded (Butler 1973) (Tables 25 and 26). In July, 1972, control of the program shifted from the Bureau of Commercial Fisheries to the EPA. A more comprehensive sampling design commenced at the beginning of FY 1973. This design calls for biannual sampling of the 200 primary estuaries of the United States and its territories that are catalogued in the National Estuarine Inventory. The monitoring of pesticide residues is based on a four-stage, alert level design. Butler (personal communication) gives a description of the methodology.

> Stage I. Collect two samples of 15 whole fish, not more than one year old, of both an herbivorous and a carnivorous species. A total of 4 samples per estuary per year. If fish contain residues of more than 1.0 ppm, initiate Stage II.
>
> Stage II. Collect two samples, 15 mature individuals each, of bivalve mollusks, e.g., oysters, in mid-summer. Continue fish samples as in Stage I. A total of six samples per estuary per year. If pesticide residues in the mollusks are more than 0.5 ppm, initiate Stage III.
>
> Stage III. Collect two samples each of 10-minute plankton tows, 15 mature mollusks, and the top one inch of bottom sediment on a quarterly basis during the year. Collect fish samples as in Stage I. A total of 28 samples per estuary per year.
>
> Stage IV. If residue levels exceed 1.0 ppm in mollusks or 5.0 ppm in fish, the appropriate state and federal agencies will be notified as they can use this information in their management and regulatory programs. It should be noted that Stages I, II, and III are not necessarily sequential and that Stage II or III may be initiated depending on the availability of funds and existing knowledge of pollution levels in specific estuaries.

Mollusks are better suited to frequent and consistent sampling to indicate seasonal variation in pesticide residues in estuarine systems. Intermittent "clean" water flows will often flush the mollusk of its bioaccumulated chemicals. Fish, therefore, have been determined to be better indicators of long-term pesticidal residue accumulation. Residues are not easily flushed from fish tissue, so less frequent sampling is possible Different trophic levels and species are now sampled to provide representative data. There is some discrepancy in the available estuary information as to exactly the number of fish and the trophic levels being sampled. Consistency in species sampled over time and from station to station is both statistically and biologically relevant.

Butler (personal communication) gives a good justification for the use of the various experimental units and the staging methodology.

> Stage I. Persistent pesticides and heavy metals are taken up by fish and stored more or less indefinitely. As a result these residues reflect the accumulation by the fish throughout its lifetime. Residues observed in filter-feeding fish indicate pollutants present either on particulate matter or in plankton

forms in the water. Residues in carnivorous fish indicate primarily those acquired through trophic magnification. Bottom-dwelling or benthic fish, less than one year old, would reflect levels of pollution occurring near the collection site. Pesticide residues in fish of less than 1.0 ppm normally indicate that pesticide pollution of the estuary is not a serious problem.

Stage II. Since fish move about, there may be uncertainty as to where they acquire pesticide residues. Mollusks, however, indicate pollution levels at the collection site. Pesticide residues are flushed out of mollusks when the pesticide pollution is abated so that periodic analyses of mollusk samples indicate when pesticide pollution occurred. Monitoring data show that when pollution in the estuary is the result of the agricultural use of pesticides, residues in mollusks are highest in mid-summer. Pesticide residues of less than 0.5 ppm in mollusks indicate an environment relatively free from pesticide pollution.

Stage III. Experimental data suggest that pesticide residue levels of over 0.5 ppm in mollusks indicate an environment in which pollution threatens the survival of some of the fuana. When pesticide residues of this magnitude are observed in mollusks, the sampling program will be expanded to include plankton and bottom sediments as well as fish and mollusks to determine whether residues are concentrated at specific sites or trophic levels.

Availability of these experimental units is not expected to be a problem. However, according to Butler (1973), "Some sites were monitored because of suspected pollution problems" during the 1965-1972 sampling period. This introduces bias into the sample and prohibits reliable assessment of long-term national levels and trends. This type of stratified, systematic sampling is best undertaken independent of the NPMP after a problem area has been identified. Additionally, every effort should be made to sample species year after year. This will serve to control the natural variability that exists between different species.

Collection techniques have changed with the change in experimental units. Samples are not obtained through the use of chemicals or intoxicants which may bias analytical results, but as with the fish program, the proper handling of fish samples is critical to the assessment of proper residue levels. Over the years samples have been shipped in "dry-powder" form. From 1965 to 1972 analyses was performed at a variety of laboratories. The current design calls for the EPA's Bay St. Louis Laboratory to handle all analyses.

Design fulfillment is best illustrated by Tables 26 and 27. Data are quite comprehensive for the 1965 through 1972 mollusk sampling period. Under the current design, all 200 estuaries were sampled during the first year of operation. Data for FY 1974 are not yet available.

Sufficient data are available under both designs (mollusks and fish) for statistical analysis, and any misssing data can be accounted for during the early years. Assessment of levels and trends is possible and has been performed to some extent (Butler 1972).

Statistical comparisons across experimental units and designs is not possible. The current design could, however, provide data for correlating residue levels in fish, mollusks, sediment, and plankton, but this type of data is not available at the present time. Correlations between herbivorous and carnivorous species of fish from the same estuary would provide information on pesticide flow. Accurate identification of problem areas should be enhanced with the new multilevel design. Through continued comprehensive coverage of all estuaries, long-term assessment can begin in a few years. Sampling and data analysis should be correlated as much as possible with fish and water categories. They are not mutually exclusive biologically and should not be considered so statistically.

Fish From Lakes and Rivers

Design changes have occurred since this program's initiation in early 1967. Originally, samples were taken twice each year as close to April and October as possible at 50 nationwide sampling sites. Beginning in 1969 sampling occurred once each year in the fall, as previous data had indicated little difference in residue levels between the spring and fall. In 1970 the number of sampling sites increased to 100 and a replicate composite sample was taken for one of the three species collected at each site (Figure 9).

Today, samples are taken at these 100 nationwide sampling stations during the fall of the year (September, October, or November). Three composite samples, each of a different species and consisting of 3 to 5 adult fishes of uniform size, are collected at each station. One replicate sample for one of the three species is also taken in order to determine the inherent variability in similar samples from the same site. The method used for selecting all 100 sample sites is unknown. It is known that the original 50 sites were selected to coincide wherever possible with sampling locations for monitoring pesticides in estuaries and water. However, according to Johnson et al (1967),

> In some instances selection of alternate locations was necessary to provide for collection sites at points where appropriate resident fish populations can be sampled, where nets can be placed in streams with some permanence and where commercial fishermen may be relied upon to take desired fishes if State or Federal crews are not available to do so.

Chemical residue analysis is replicated for each sample, making a total of 600 samples analyzed.

Fish samples are collected by various means, including seines, gill nets, traps, hook and line, electrofishing, etc., and some are purchased from commercial fishermen. One requirement is that fishes not be taken through the use of fish toxicants or other chemicals. No one sampling technique is consistently used, but bias would occur more with variation in the type, size, and age of the species collected. Problems in analytical techniques also occurred in the early years due to the fact that several laboratories were doing the chemical analysis.

Fish species sampled at each site are to be representative of the resident population at or near the top of the food chain. However, ease in capture should not determine the "typical" resident species. This has been known to be the sampling criteria in some cases.

Since the program began it was recognized that, due to variation between streams the same fish species could not be collected at all stations. It was determined to collect three species at each station, preferably from a list of species at the top of the food chain. These originally included carp, buffalo, black bass, channel catfish, green sunfish, yellow perch, rainbow trout, and squawfish. Some of the preferred species could not be collected. The list was then expanded to include suckers, other catfish, other trout, etc. An attempt is made to collect the same three species from each station from year-to-year.

There are many difficulties associated with obtaining a representative fish sample. The variability between fish species within and among sampling stations is large. Although some inherent variability is dealt with through sampling of three species at each site, it is also important that different trophic levels be represented by each composite sample. Thus, the inherent variability associated with differing feeding habits and metabolic rates between trophic levels can be accounted for.

As an example of the problems encountered while trying to meet the design requirements, Henderson et al (1969) stated,

> More difficulty was encountered than had been anticipated in collecting the same species of fish at a particular station during all sampling periods. Only at 9 stations were the same 3 species collected during all 4 sampling periods. Two of the same species were collected at an additional 11 stations and 1 at an additional 21 stations. Thus, 41 of the 50 stations had at least 1 species collected during all periods.
>
> Also, more species were collected than had been anticipated. There were 62 species in the 590 composite samples. However, of these, 21 species were collected at only 1 station, 12 at 2 stations, and an additional 6 at only 3 of the 50 stations. On the other hand, some species or genera were represented at many stations. A total of 97 samples of carp were collected at 34 stations, 105 samples of catfish at 31 stations, 111 samples of suckers at 35 stations, and 61 samples of black bass at 22 stations.

Table 40 indicates that a high percentage of the required numbers were obtained. However, given both the difficulty in obtaining samples of the same species over time and the early problems encountered during residue analysis, the reliability of statistical analysis with respect to the older data is in question. For instance, prior to 1970, replicate composite samples were not taken to measure normal variations. In addition, the 1967 and 1968 samples were divided among three laboratories without arrangement for cross-checking of shared samples. A later cross-check of shared samples revealed that reported residue levels varied by several orders of magnitude, in some cases (Spencer 1974). Recent data, however, are of better quality due to improved sampling and analytical procedures. The addition of replicate samples beginning in 1970 has improved the reliability of both statistical and analytical results. No data are available for 1971.

TABLE 40. MONITORING RESIDUES IN FISH--DESIGN FULFILLMENT FOR FY 1967-1972

Fiscal Year	No. of Sample Sites	No. of Sample Periods/ Year	No. of Composite Samples Called For by Design	Actual No. of Samples Taken	Percent	No. of Replicate Samples Called For By Design	Actual No. of Replicate Samples Taken	Percent
1967	50	2	300	300	100	0	-	-
1968	50	2	300	284	94.7	0	-	-
1969	50	1	150(a)/150(b)	147/145	98.0(a)/ 96.7(b)	0	-	-
1970	100	1	300	296	98.7	100	97	97.0
1971	100	1	300	(c)	(c)	100	(c)	(c)
1972	100	1	300	294	98.0	100	99	99.0

(a) Organochlorine.
(b) Mercury.
(c) Information not available.

Before analyzing these data statistically, it would be advisable to block out some variation due to drainage systems or geographic land use patterns. Different areas have different pesticide use characteristics affecting run-off waters and ultimately fish pesticide residue levels. Analysis could simply be made across all stations, but the differences found would be rather obvious. It is important to assess inherent variability between fish species within and across trophic levels. It may be found that variation between trophic levels is a function of species variability within the trophic levels. This would indicate that valid statistical comparisons could be made across different fish species. Subsample analysis within each species would also be desirable.

Assuming pesticide residue levels can be determined quickly, this environmental component should help in identifying problem areas. Correlation with other NPMP categories might prove very valuable given consistency in chemical analytical techniques. Analysis of long-term trends, however, is also dependent on consistency. Good nationwide sampling began in 1970, but prior to this time sampling and analytical methodologies were changing from year-to-year. Assuming no more significant changes occur and that the 1971 data become available, trend analysis could be attempted starting with 1970 data.

Mallard and Black Ducks

According to Heath (1969),

> The design to monitor mallard and black duck wings was based on several factors: (a) the combined range of the two species covers the continental United States, the mallard being relatively abundant in all but the eastern States where the black duck predominates; (b) wings were readily available as a byproduct of an established nationwide survey of waterfowl productivity wherein each fall cooperating hunters mail the Bureau tens of thousands of duck wings for biological examination; and (c) Dindal and Peterle (1968) using DDT, ring-labeled with chlorine-36, to study DDT dispersion in a marsh ecosystem, found highly significant correlations in 104 captive mallards and scaup ducks between DDT residues in wings and those in breast skin, kidney, breast muscle, uropygial gland, adrenal gland, pancreas, brain, gonads, liver, and thyroid. The average level in the wings was essentially equal to the median level in the above body parts; it was approximately twice that in breast muscle and about one-eighth that in the uropygial gland.

Sampling and analysis for pesticide residues began in FY 1966. Beginning in FY 1967 sampling has taken place on a nationwide basis every three years. Participating hunters mail duck wings to the U. S. Fish and Wildlife Service noting the date, state, and county of each capture. Mallards are found and collected nationwide while black ducks occur primarily in the Atlantic flyway and are, therefore, monitored in that region only. Biologists determine the species, sex, and maturity of the bird. Analysis is made on pools of 25 unfeathered wings from the same state in order to increase the precision of average residue levels. The number of pools analyzed is proportional to the state's duck harvest during the respective year.

It is statistically important to know exactly how many hunters are selected from the parent population comprised of all hunters. Sampling bias could easily be introduced here.

In 1966 and 1967 pesticide levels were monitored in both immature and adult duck wings proportional to each state's harvest. According to Heath and Hill (1974), "...monitoring in 1970 was restricted to adult wings; of those chemicals consistently detected in earlier monitoring (DDE, DDT, DDD, and Dieldrin), only DDE proved to have higher residue levels in adult wings than in immature wings." It is not known whether both adult and immature duck wings from 1973 will be analyzed. Mercury and PCB's were first monitored in 1970.

Several critical assumptions are being made about these experimental units. Ducks captured in a particular flyway are not necessarily representative of that flyway. Kortright (1967) says, "Migration studies...have shown that by adhering more or less rigidly to any particular flyway the ducks...tend to perpetuate not only that ancestral route but also the groups of individuals that use it." However, as can be seen in Figure 12 ducks entering the United States from Alaska or Canada may use several of the flyways during migration. Pesticidal contamination may have occurred in Canada and as such would not be representative of U. S. national levels or trends from a NPMP standpoint.

It would appear more logical to collect samples during the spring migration. There are, however, difficulties involved in such an approach. The current design utilizes experimental units which are readily available as a byproduct of an established nationwide survey of waterfowl productivity. Initiating a spring migration sampling scheme would require a new experimental design, the development of new sampling procedures, and additional financial resources to support sample collection efforts. However, a spring migration sampling scheme operated in conjunction with the current program would provide for a more accurate assessment of national pesticide levels, trends, and sources of contamination. If both sets of data were available, an assessment could be made as to whether the two sampling periods really do produce statistically different results.

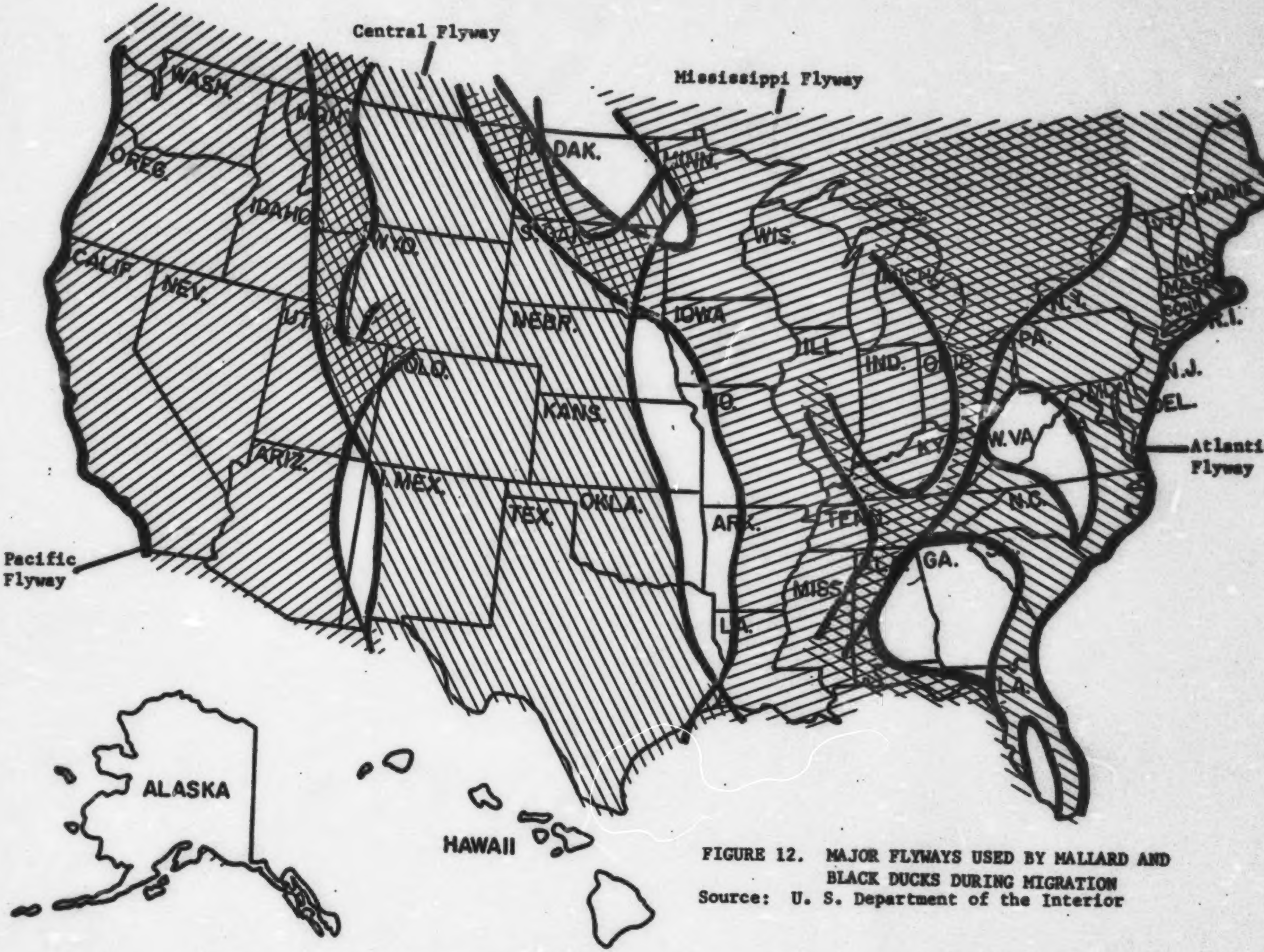
Central Flyway
Mississippi Flyway
Pacific Flyway
Atlantic Flyway
WASH.
MONT.
OREG.
IDAHO
WYO.
N. DAK.
MINN.
S. DAK.
WIS.
MICH.
N.Y.
MAINE
VT.
N.H.
MASS.
CONN.
R.I.
CALIF.
NEV.
UTAH
COLO.
NEBR.
IOWA
ILL.
IND.
OHIO
PA.
N.J.
DEL.
MD.
KANS.
MO.
KY.
W.VA.
ARIZ.
N. MEX.
TEX.
OKLA.
ARK.
TENN.
N.C.
S.C.
MISS.
ALA.
GA.
LA.
FLA.
ALASKA
HAWAII

FIGURE 12. MAJOR FLYWAYS USED BY MALLARD AND BLACK DUCKS DURING MIGRATION

Source: U. S. Department of the Interior

Data are presently available for only three of the four sampling periods. Data as shown in Table 32 are pooled for FY 1966 and FY 1967, but are available in yearly form. No data have been reported for FY 1973. Although differences can now be detected within years, differences across years will be more valuable when several more years of data become available. At that time, trends can be established. Due to the every third year sampling frequency, short-term problem areas may go undetected. However, as stated by Heath and Prouty (1967), even if good data were available every year, "...the mobility of the species might permit only a general location of the source of contamination, (but) monitoring of localized material (soil, crops, etc.) by other agencies should help identify such concentrations." It is not apparent that this type of data correlation is being done.

Heath and Hill (1974) give a good discussion of statistical comparisons that can be made and some of the necessary assumptions:

> ...a multitude of statistical comparisons of residue levels is possible both between states and between years within states. In many instances differences clearly are either significant or not significant. Caution is suggested, however, when the distinction is not clear-cut: the individual pool values may facilitate a more rigorous test of significance than is possible using pool means and their standard errors. Caution is also suggested in combining data from adjacent states unless the data have been properly weighted.

As indicated by Sprunt and Zim (1961), "The flyways are not rigid. Both to the north and south they overlap and are not well defined. But, across the United States they are more pronounced." This, and the fact that any blocking usually takes place across a gradiant, would seem to imply that analysis on an east-west basis may be more reliable than on a north-south or flyway basis. In this case blocking or whole plots could be delineated on some sort of longitudinal basis. Assessment of trends should be possible over the sampling periods through regression analysis. Without continuous yearly sampling, however, duck population residue levels between sampling periods have no effect on the regression line except through possible autocorrelation. Attempting to correlate levels and trends between mallards and black ducks may also provide useful information.

Starlings

The starling was selected for monitoring residual pesticides in the environment because it is a terrestrial species found year-round throughout most of the contiguous 48 states. It is generally regarded as expendable and its omnivorous food habits were expected to reflect the general environmental presence of persistent pesticides and certain heavy metals (Dustman et al 1971). However, one critical assumption has been made from a statistical and biological standpoint. It should be remembered that starlings captured at a particular site may not be representative of the resident population of the area. Migratory and feeding patterns must be taken into account when interpreting any statistical inferences made from the data.

Several design changes have been made since this category's beginning in August-September, 1967. The original plan called for taking one composite sample of ten birds at each of 139 sites in 44 blocks during the late summer and winter. This sampling frequency was followed in 1967 and 1968 (Table 33). No sampling occurred in 1969.

Since 1970 the block design of this program appears more statistically sound. The design consists of 40, 5° latitude/longitude blocks covering the contiguous 48 states. Up to 4 randomly-selected sites are sampled from each block (Figure 10). Composite samples of ten birds are collected at each site during November-December of each year. Statistically speaking, it would be better to take fewer subsamples (e.g., less than ten) but sample at more than four sites within each block. This would produce a more representative sample about which better inferences could be made.

In 1970, it was determined that mercury residues were to be analyzed for all samples while lead analysis was to be performed for a possible 25 city sampling sites. Beginning in 1971, it was decided to report heavy metal residue findings for mercury, lead, cadmium, and arsenic from a possible 53 preselected sites during odd-numbered years and to report organochlorine residues during even-numbered years. Selenium was added as a monitored heavy metal in 1973 (Table 33). These changes in timing and sample size are important, but can be handled statistically since the underlying block design is the same.

A comparison of the established design and its percent sample fulfillment is given in Table 41. As can be seen, fulfillment has been good. What little missing data there are should provide no problem statistically.

A closer examination shows that sample size is very low for heavy metals (Table 41). Transformations on the data may make it more amenable to statistical analysis, but determining heavy metal national levels and trends and particularly identifying problem areas may be difficult with only 53 sample sites.

TABLE 41. MONITORING RESIDUES IN STARLINGS--DESIGN FULFILLMENT FOR FY 1967-1973

Fiscal Year	Analysis Made	Design Sample Sites	Sites Actually Sampled	Percent Sampled
1967	Organochlorine	139	128	92.1
1968	Organochlorine	139	128	92.1
1969	No samples taken	-	-	-
1970	Organochlorine and Mercury	139	125	89.9
	Lead	25	23	92.0
1971	Mercury, Lead, Arsenic, and Cadmium	53	50	94.3
1972	Organochlorine	139	130	93.5
1973	Mercury, Lead, Arsenic, Cadmium, and Selenium	53	52	98.1

Long-term trend analysis for heavy metals is dependent on several more years of data. Just three years of data are available for mercury and lead, two years for arsenic and cadmium, and only one year for selenium. Assuming no significant design changes over time, baseline and trend analysis for organochlorine data can proceed. Statistical analysis for heavy metal residues should be handled separately.

Due to geographic location, variation among samples within blocks is expected to be less than among samples across blocks. Increased error control might, therefore, be achieved by blocking. Several factors can be analyzed here. Variation can be determined among years, among blocks within and across years, among composites and subsamples within composites, and among pesticides within and across years. Additionally, through careful geographic pooling of the data, variation on a regional, north-south, or east-west basis might be accounted for. This might lend itself well to a Latin square arrangement within a split plot ANOVA where the interaction between rows (east-west) and columns (north-south) could be determined.

CHAPTER 5. STATE MONITORING ACTIVITIES

Although the EPA is now playing the leading role in monitoring environmental pesticide residue levels, many other monitoring activities are being conducted by various state agencies, either on an ad-hoc or periodic basis. These activities add yet another dimension to the store of available data pertaining to pesticide residues in various environmental strata. Consequently, such activities are of interest to the EPA from the standpoint of potentially augmenting the data being collected by the NPMP.

The purpose of this chapter is to present information concerning the types of data presently available from the various state programs. As such, it is not intended to be an in-depth assessment of the quality of data collected by state agencies. The input to this chapter was obtained from the results of a recently completed draft report of a survey of state monitoring activities conducted by the Smithsonian Center for Short-Lived Phenomena under contract to EPA's Office of Monitoring Systems.

Briefly, the Smithsonian survey contacted personnel in all fifty states to ascertain the types of environmental monitoring activities presently conducted by the state agencies. Responses to the survey were compiled, and the results relative to pesticide monitoring activities were furnished to BCL for inclusion in this report. The data thus obtained were reviewed and recompiled to the extent possible in accordance with the parameters utilized for compilation of the NPMP data presented in Chapter 3 (i.e., environmental component monitored, frequency of collection, number and location of samples taken, and chemicals monitored).

Table 42 summarizes the pesticide monitoring activities by state and environmental component(s) monitored, as shown by the Smithsonian survey. As can be seen, thirty-one states reported some degree of on-going pesticide monitoring activities. Table 43 to 51 present detailed compilations by environmental component monitored. From the data reviewed, it was not possible to accurately ascertain, in many instances, the number of samples taken per year or the number of sample sites for each individual environmental component monitored. Also, most of the state activities utilize chromatographic analytical procedures. However, the data reported do not include operating parameters for the various analytical techniques.

TABLE 42. SUMMARY OF STATE MONITORING ACTIVITIES

	Air	Animals	Drainage Water	Drinking Water	Food and Feed	Man	Marine Water	Plants	Sediment	Sewage	Soil	Water
Arizona				X	X	X						X
Arkansas	X			X	X							X
California		X	X	X			X					X
Colorado		X						X	X	X	X	X
Connecitcut							X		X			X
Delaware							X					
Florida		X			X							
Georgia				X	X			X			X	X
Idaho	X	X		X	X	X		X	X	X	X	X
Illinois		X			X			X	X	X		X
Indiana		X			X							
Kansas												X
Maine					X							
Maryland												X
Michigan		X			X				X	X		X
Minnesota												
Mississippi		X							X		X	X
Nevada	X	X			X			X			X	X
New York		X			X			X			X	
North Carolina		X					X		X			X
Ohio			X									X
Oklahoma		X	X		X			X	X	X		X
Oregon					X							
Rhode Island			X		X							X
South Carolina												X
Tennessee					X			X				
Texas		X			X			X				
Utah	X	X	X		X					X	X	X
Virginia							X					X
West Virginia		X										
Wisconsin		X			X			X			X	

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TABLE 43. STATE AIR MONITORING PROGRAMS

State	Chemical	Coverage	Number of Sites	Sampling Frequency	Samples/Year	Analytical Method	Analytical Percision	Data Storage	Date Began
Arkansas	Chlorinated Hydrocarbons	Local,Statewide	Non-Fixed	Periodic	Non-Fixed	EPA Analytical Methods	>95%	Unpublished Records	7/71
	Organo Phosphates	" "	"	"	"	" " "	"	" "	"
	Phenoxy Herbicides	" "	"	"	"	" " "	"	" "	"
	Carbamates	" "	"	"	"	" " "	"	" "	"
	Dithiocarbamates	" "	"	"	"	" " "	"	" "	"
Idaho	Chlorinated Hydrocarbons	Statewide	Not Determinable	Continuous	Not Determinable	E.C., I.L.C.	--	Computer	5/68-6/70
	Organo Phosphates	"	"	"	"	E.C., I.L.C., F.P.	--	"	"
Nevada	Chlorinated Hydrocarbons	Statewide	Not Determinable	Periodic	Not Determinable	G.C.	90%		0/71
	Organo Phosphates	"	"	"	"	"	97%		"
	Phenoxy Herbicides	"	"	"	"	"	85%		"
	Carbamates	"	"	"	"	"	90%		"
Utah	Chlorinated Hydrocarbons	Local,Statewide	Unknown	Periodic	Not Determinable	G-L-C.	PP13		1/68

TABLE 4. STATE ANIMAL MONITORING PROGRAMS

State	Animal Type	Chemical	Coverage	Number of Sites	Sampling Frequency	Samples/ Year	Analytical Methods	Analytical Precision	Data Storage	Date Began
California	Fish & Wildlife	Chlorinated Hydrocarbons	Statewide	12	Periodic	200	G.L.C.	10PPB	Published Papers, Unpublished Records	0/62
Colorado	Not Specified	Chlorinated Hydrocarbons	Statewide	Unknown	Continuous Sporadic	Not Determinable	T.L.C.,G.L.C.	PPM	Unpublished Records	0/65
		Organo Phosphates	"	"	"	"	"	"	"	"
		Triazine Herbicides	"	"	"	"	"	"	"	"
		Phenoxy Herbicides	"	"	"	"	"	"	"	"
		Carbamates	"	"	"	"	"	"	"	"
		Dithiocarbamates	"	"	"	"	"	"	"	"
		Dinitroaniline	"	"	"	"	"	"	"	"
Florida	Wildlife	Chlorinated Hydrocarbons	Statewide	Numerous	Continuous	30	G.C.	+OR-0.1PPM	Published Papers, Unpublished Records	1/70
		Organo Phosphates	"	"	"	"	"	"	"	"
	Brown Pelicans	Chlorinated Hydrocarbons	"	Unknown	Periodic	30	"	"	"	1/68
		Organo Phosphates	"	"	"	"	"	"	"	"
Idaho	Not Specified	Chlorinated Hydrocarbons	Statewide	Not Determinable	Continuous	Not Determinable	E.C.,T.L.C.	Unknown	Computer, Published Papers	5/68
		Organo Phosphates	"	"	Periodic	"	"	"	"	"
		Carbamates	"	"	Sporadic	"	F.P.,E.C.,C.	"	Computer	"
		Dithiocarbamates	"	"	"	"	"	"	"	"
Illinois	Fish	Chlorinated Hydrocarbons	Statewide	Not Determinable	Sporadic	Not Determinable	E.C.G.C.	Unknown	Unpublished Papers	7/74
		Polychlorinated Biphenyls	"	"	"	"	"	"	"	"
		Chlorinated Hydrocarbons	Local	"	Periodic	"	"	"	Published Papers	7/71
		Polychlorinated Biphenyls	"	"	"	"	"	"	"	"
Indiana	Fish	Chlorinated Hydrocarbons	Local	As Required	Periodic	As Required	G.C.	Unknown	Unpublished Papers	---
Michigan	Fish	Chlorinated Hydrocarbons	Statewide	Variable	Continuous	Variable	G.C.	Unknown	Computer,Unpublished Records, Published Papers	6/71
		Organo Phosphates	"	"	"	"	"	"	"	"
		Triazine Herbicides	"	"	"	"	"	"	"	"
		Phenoxy Herbicides	"	"	"	"	"	"	"	"
		Carbamates	"	"	"	"	"	"	"	"
		Dithiocarbamates	"	"	"	"	"	"	"	"
		Dinitroaniline	"	"	"	"	"	"	"	"
	Fish	Chlorinated Hydrocarbons	Statewide	20	Periodic	600	G.L.C.,A.A.	0.01PPM	Unpublished Papers	3/72
Mississippi	Fish	Chlorinated Hydrocarbons	Statewide	Not Determinable	Periodic	Not Determinable	G.L.C.	Unknown	Published Papers	2/69
Nevada	Not Specified	Chlorinated Hydrocarbons	Statewide	Not Determinable	Periodic	Not Determinable	G.C.	90%	Unpublished Papers	0/71
		Organo Phosphate	"	"	"	"	"	"	"	"
		Phenoxy Herbicides	"	"	"	"	"	"	"	"
		Carbamates	"	"	"	"	"	"	"	"
New York	Not Specified	Chlorinated Hydrocarbons	Statewide	Unknown	Continuous	Not Determined	F.D.A.,P.A.M.	Unknown	Computer	---
		Organo Phosphates	"	"	"	"	"	"	"	---
North Carolina	Fish	Chlorinated Hydrocarbons	Statewide	33	Periodic	99	G.C.	17-42%	Computer	11/73
Oklahoma	Not Specified	Chlorinated Hydrocarbons	Local	15	Periodic	371	Unknown	Unknown	Unpublished Records	1/74
Texas	Not Specified	Chlorinated Hydrocarbons	Statewide	Unknown	Continuous	Not Determinable	G.C.	PPT	Computer	9/65
		Organo Phosphates		"	"	"	"	"	"	"
		Triazine Herbicides		"	"	"	"	"	"	"
		Phenoxy Herbicides		"	"	"	"	"	"	"
		Carbamates		"	"	"	"	"	"	"
		Dithiocarbamates		"	"	"	"	"	"	"
		Dinitroaniline		"	"	"	"	"	"	"
Utah	Not Specified	Chlorinated Hydrocarbons	Local,Statewide	Unknown	Periodic	Not Determinable	G.L.C.	PPB	Computer, Unpublished Records	1/68
West Virginia	Honey Bees	Chlorinated Hydrocarbons	Statewide	10	Periodic	30	PAM212	Unknown	Unpublished Papers	4/74
		Organo Phosphates	"	"	"	"	JAOAC Vol.54	"	"	"
		Carbamates	"	"	"	"	RTL	"	"	"
Wisconsin	Not Specified	Chlorinated Hydrocarbons	Statewide	Unknown	Continuous	500	G.L.C.	1PPB	Unpublished Records	0/64

TABLE 45. STATE DRINKING WATER MONITORING PROGRAMS

State	Chemical	Coverage	Number of Sites	Sampling Frequency	Samples/Year	Analytical Method	Analytical Percision	Data Storage	Date Began
Arizona	Chlorinated Hydrocarbons	Local	4	Periodic	48	G.C.	>10%	Unpublished Records	0/69
	Organo Phosphates	"	"	"	"	"	"	"	"
	Carbamates	"	"	"	"	"	"	"	"
Arkansas	Chlorinated Hydrocarbons	Local,Statewide	Non-Fixed	Periodic	Non-Fixed	EPA Analytical Methods	>95%	Unpublished Records	7/71
	Organo Phosphates	"	"	Periodic,Sporadic	"	"	"	"	"
	Phenoxy Herbicides	"	"	"	"	"	"	"	"
	Carbamates	"	"	"	"	"	"	"	"
	Dithiocarbamates	"	"	"	"	"	"	"	"
Colorado	bChlorinated Hydrocarbons	Statewide	Unknown	Continuous,Sporadic	Not Determinable	T.L.C.,G.L.C.	PPM	Unpublished Records	0/65
	bOrgano Phosphates	"	"	"	"	"	"	"	
	bTriazine Herbicides	"	"	"	"	"	"	"	
	bPhenoxy Herbicides	"	"	"	"	"	"	"	
	bCarbamates	"	"	"	"	"	"	"	
	bDithiocarbamates	"	"	"	"	"	"	"	
	bDinitoroaniline	"	"	"	"	"	"	"	
Georgia	Chlorinated Hydrocarbons	Statewide	Unknown	Sporadic	5-10	G.C.	--	Unpublished Records	1/62
	Organo Phosphates	"	"	"	"	"	--	"	"
Idaho	Chlorinated Hydrocarbons	Statewide	Unknown	Continuous	Not Determinable	E.C.,T.L.C.	--	Computer	5/68
	Organo Phosphates	"	"	Periodic	"	E.C.,T.L.C.,F.P.	--	"	3/68 66/70
Ohio	Chlorinated Hydrocarbons	Statewide	168	Periodic	400	G.C.	91.6%	Computer	7/73
	Organo Phosphates	"	"	"	"	"	89.7%	"	"
Oklahoma	Chlorinated Hydrocarbons	Statewide	Not Determinable	Sporadic	Not Determinable	G.C.	+OR-10%	Computer	2/73
	Organo Phosphates	"	"	"	"	"	"	"	"
Rhode Island	Chlorinated Hydrocarbons	Statewide	Unknown	Continuous	195	FWPCA	Unknown	Unpublished Records	0/72
	Organo Phosphates	"	"	Sporadic	<10	"	"	"	"
	Carbamates	"	"	"	<20	"	"	"	"
Utah	Chlorinated Hydrocarbons	Local,Statewide	Unknown	Periodic	Not Determinable	G.L.C.	PPB	Computer	1/68

b = Monitored only if commercial applicators are involved.

TABLE 44. STATE FOOD MONITORING PROGRAMS

State	Food Type	Chemical	Coverage	Number of Sites	Sampling Frequency	Samples/Year	Analytical Methods	Analytical Precision	Data Storage	Date Began
Arizona	Milk	Chlorinated Hydrocarbons	Statewide	All Dairies	Periodic	2000	G.C.	>60%	Unpublished Records	0/69
		Organo Phosphates	"	"	"	"	"	"	"	"
		Phenoxy Herbicides	"	"	"	"	"	"	"	"
Arkansas	Beef Cattle	Chlorinated Hydrocarbons	Local, Statewide	Non-Fixed	Periodic	Non-Fixed	EPA Analytical Methods	>95%	Unpublished Records	7/71
		Organo Phosphates	"	"	Periodic, Sporadic	"	"	"	"	"
		Phenoxy Herbicides	"	"	"	"	"	"	"	"
		Carbamates	"	"	"	"	"	"	"	"
		Dithiocarbamates	"	"	"	"	"	"	"	"
Florida	Food Products	Chlorinated Hydrocarbons	Statewide	5	Continuous	10,000	G.L.C.	0.01PPM	Computer	0/39
		Organo Phosphates	"	"	"	"	"	"	"	"
		Triazine Herbicides	"	"	"	"	"	"	"	"
		Phenoxy Herbicides	"	"	"	"	"	"	"	"
		Carbamates	"	"	"	"	"	"	"	"
		Dithiocarbamates	"	"	"	"	"	"	"	"
Georgia	Vegetables, Meat, Dairy Products	Chlorinated Hydrocarbons	Statewide	Unknown	Continuous	700	G.C.	Unknown	Unpublished Records	1/62
		Organo Phosphates	"	"	"	"	"	"	"	"
	Food Ingredients	Chlorinated Hydrocarbons	"	"	"	280	"	"	"	"
		Organo Phosphates	"	"	"	"	"	"	"	"
Idaho	Not Specified	Chlorinated Hydrocarbons	Statewide	Unknown	Continuous	Not Determinable	E.C.,T.L.C.	Unknown	Computer, Published Papers	3/68
		Organo Phosphates	"	"	Periodic	"	E.C.,T.L.C.,F.P.	"	"	"
		Carbamates	"	"	Sporadic	"	F.P.,E.C.,C.	"	Computer	"
		Dithiocarbamates	"	"	"	"	"	"	"	"
Illinois	Milk	Chlorinated Hydrocarbons	Statewide	Varies	Continuous	300	G.C.	0.3PPM	Unpublished Records	7/72
		Organo Phosphates	"	"	"	"	"	"	"	"
		Carbamates	"	"	"	"	"	"	"	"
	Fish	Chlorinated Hydrocarbons	"	5	"	300	"	"	"	10/70
		Organo Phosphates	"	"	"	"	"	"	"	"
	Meat (Beef)	Chlorinated Hydrocarbons	"	"	"	120	"	0.01PPM	Published Papers, Unpublished Records	9/71
		Organo Phosphates	"	"	"	"	"	"	"	"
Indiana	Not Specified	Chlorinated Hydrocarbons	Statewide	25	Periodic	700	FDA Multiresidue Procedure	Good	Unpublished Records	3/63
		Organo Phosphates	"	"	"	"	"	"	"	"
Maine	Livestock	Chlorinated Hydrocarbons	Statewide	Unknown	Continuous	120	A.O.A.C.,G.C.	Unknown	Unpublished Records	0/72
Michigan	Milk	Chlorinated Hydrocarbons	Statewide	Unknown	Continuous	500	G.L.C.	+OR-2%	Unpublished Records	0/65
		Organo Phosphates	"	"	"	"	"	"	"	"
	Fruits and Vegetables	Unknown	Unknown	"	Unknown	Unknown	Unknown	Unknown	Unknown	--
Nevada	Not Specified	Chlorinated Hydrocarbons	Statewide	Not Determinable	Periodic	Not Determinable	G.C.	90%	Unpublished Records	0/71
		Organo Phosphates	"	"	"	"	"	"	"	"
		Phenoxy Herbicides	"	"	"	"	"	"	"	"
		Carbamates	"	"	"	"	"	"	"	"
New York	Food and Animal Food	Chlorinated Hydrocarbons	Statewide	Unknown	Continuous	Not Determinable	FDA PAM	Unknown	Computer	--
		Organo Phosphates	"	"	"	"	"	"	"	--
		Carbamates	"	"	Periodic	"	"	"	"	--
		Dithiocarbamates	"	"	"	"	"	"	"	--
		Dinitroaniline	"	"	Sporadic	"	"	"	"	--
Oklahoma	Not Specified	Chlorinated Hydrocarbons	Statewide	Unknown	Periodic	Unknown	Unknown	<1PPB	Unpublished Records	--
		Organo Phosphates	"	"	"	"	"	"	"	--
		Phenoxy Herbicides	"	"	Sporadic	"	"	"	"	--
Oregon	Fruits, Vegetables, Dairy Products	Chlorinated Hydrocarbons	Statewide	Unknown	Periodic	Unknown	G.C.	10PPB	Unpublished Records	--
		Organo Phosphates	"	"	"	"	"	"	"	--
		Phenoxy Herbicides	"	"	"	"	"	"	"	--
Rhode Island	Not Specified	Chlorinated Hydrocarbons	Statewide	Unknown	Continuous	250	P.A.M.	Unknown	Unpublished Records	0/67
		Organo Phosphates	"	"	"	Varies	"	"	"	"
		Carbamates	"	"	Sporadic	10-20	A.O.A.C.	"	"	"
Tennessee	Dairy Products and Meat	Chlorinated Hydrocarbons	Statewide	Unknown	Continuous	Unknown	A.O.A.C.,G.C.	Unknown	Unpublished Records	4/61
		Organo Phosphates	"	"	"	"	"	"	"	"
Texas	Raw Agricultural Products	Chlorinated Hydrocarbons	Statewide	Unknown	Continuous	Not Determinable	G.C.	PPT	Computer	9/65
		Organo Phosphates	"	"	"	"	"	"	"	"
		Triazine Herbicides	"	"	"	"	"	"	"	"
		Phenoxy Herbicides	"	"	"	"	"	"	"	"
		Carbamates	"	"	"	"	"	"	"	"
		Dithiocarbamates	"	"	"	"	"	"	"	"
		Dinitroaniline	"	"	"	"	"	"	"	"
Utah	Not Specified	Chlorinated Hydrocarbons	Local, Statewide	Unknown	Periodic	Not Determinable	G.L.C.	PPB	Computer, Unpublished Records	1/68
Wisconsin	Not Specified	Chlorinated Hydrocarbons	Statewide	Unknown	Continuous	4400	G.L.C.	0.1PPM	Unpublished Records	0/64
		Organo Phosphates	"	"	"	700	"	"	"	"
		Carbamates	"	"	"	"	"	"	"	"

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TABLE 47. STATE PLANT MONITORING PROGRAMS

State	Plant Type	Chemical	Coverage	Number of Sites	Sampling Frequency	Samples/Year	Analytical Methods	Analytical Precision	Data Storage	Date Began
Colorado	Not Specified	Chlorinated Hydrocarbons	Statewide	Unknown	Continuous, Sporadic	Not Determinable	T.L.C.,G.L.C.	PPM	Unpublished Records	0/65
		Organo Phosphates	"	"	"	"	"	"	"	"
		Triazine Herbicides	"	"	"	"	"	"	"	"
		Phenoxy Herbicides	"	"	"	"	"	"	"	"
		Carbamates	"	"	"	"	"	"	"	"
		Dithiocarbamates	"	"	"	"	"	"	"	"
		Dinitronaniline	"	"	"	"	"	"	"	"
Georgia	Not Specified	Chlorinated Hydrocarbons	Statewide	Unknown	Sporadic	Unknown	G.C.	Unknown	Unpublished Records	1/62
		Organo Phosphates	"	"	"	"	"	"	"	"
		Phenoxy Herbicides	"	"	"	"	"	"	"	"
Idaho	Not Specified	Chlorinated Hydrocarbons	Statewide	Unknown	Continuous	Not Determinable	E.C.,T.L.C.	Unknown	Computer,Published Papers	5/68
		Organo Phosphates	"	"	Periodic	"	E.C.,T.L.C.,F.P.	"	"	"
		Triazine Herbicides	"	"	Sporadic	"	E.C.	"	"	"
		Phenoxy Herbicides	"	"	"	"	"	"	"	"
		Carbamates	"	"	"	"	F.P.,E.C.,C.	"	"	"
		Dithiocarbamates	"	"	"	"	"	"	"	"
Illinois	Soybeans	Chlorinated Hydrocarbons	Statewide	100	Periodic	100	G.L.C.	>95%	Published Papers, Unpublished Records	10/65
Nevada	Not Specified	Chlorinated Hydrocarbons	Statewide	Not Determinable	Periodic	Not Determinable	G.C.	90%	Unpublished Records	0/71
		Organo Phosphates	"	"	"	"	"	97%	"	"
		Phenoxy Herbicides	"	"	"	"	"	85%	"	"
		Carbamates	"	"	"	"	"	90%	"	"
New York	Not Specified	Chlorinated Hydrocarbons	Statewide	Unknown	Continuous	Not Determinable	F.D.A.,P.A.M.	Unknown	Computer	--
		Organo Phosphates	"	"	"	"	"	"	"	--
		Triazine Herbicides	"	"	Sporadic	"	"	"	"	--
		Phenoxy Herbicides	"	"	"	"	"	"	"	--
		Carbamates	"	"	Periodic	"	"	"	"	--
		Dithiocarbamates	"	"	"	"	"	"	"	--
		Dinitroaniline	"	"	"	"	"	"	"	--
Oklahoma	Not Specified	Chlorinated Hydrocarbons	Statewide	Not Determinable	Periodic	Not Determinable	F.W.P.C.A.	<1PPB	Unpublished Records	--
		Organo Phosphate	"	"	"	"	"	"	"	--
		Phenoxy Herbicides	"	"	"	"	U.S.G.S.	<0.1PPB	"	--
Tennessee	Not Specified	Phenoxy Herbicides	Unknown	Unknown	Unknown	Unknown	T.L.C.	Unknown	Unpublished Records	4/61
Texas	Not Specified	Chlorinated Hydrocarbons	Statewide	Unknown	Continuous	Not Determinable	G.C.	PPT	Computer	9/65
		Organo Phosphates	"	"	"	"	"	"	"	"
		Triazine Herbicides	"	"	"	"	"	"	"	"
		Phenoxy Herbicides	"	"	"	"	"	"	"	"
		Carbamates	"	"	"	"	"	"	"	"
		Dithiocarbamates	"	"	"	"	"	"	"	"
		Dinitroaniline	"	"	"	"	"	"	"	"
Wisconsin	Not Specified	Chlorinated Hydrocarbons	Statewide	Unknown	Periodic	50	G.L.C.	1PPB	Unpublished Records	0/64
		Organo Phosphates	"	"	"	"	"	10PPB	"	"
		Triazine Herbicides	"	"	"	"	"	"	"	"
		Phenoxy Herbicides	"	"	"	"	"	"	"	"
		Carbamates	"	"	"	"	"	"	"	"
		Dithiocarbamates	"	"	"	"	"	0.1PPM	"	"

TABLE 48. STATE SEDIMENT MONITORING PROGRAMS

State	Chemical	Coverage	Number of Sites	Sampling Frequency	Samples/Year	Analytical Methods	Analytical Precision	Data Storage	Date Began
Colorado	Chlorinated Hydrocarbons	Statewide	Unknown	Continuous,Sporadic	Not Determinable	T.L.C.,G.L.C.	PPM	Unpublished Records	0/65
	Organo Phosphates	"	"	"	"	"	"	"	"
	Triazine Herbicides	"	"	"	"	"	"	"	"
	Phenoxy Herbicides	"	"	"	"	"	"	"	"
	Carbamates	"	"	"	"	"	"	"	"
	Dithiocarbamates	"	"	"	"	"	"	"	"
	Dinitroaniline	"	"	"	"	"	"	"	"
Connecticut	Chlorinated Hydrocarbons	Statewide	45	Periodic	Unknown	G.C.	Unknown	Computer	7/74
	Organo Phosphates	"	"	"	"	"	"	"	"
	Phenoxy Herbicides	"	"	"	"	"	"	"	"
	Dinitroaniline	"	"	"	"	"	"	"	"
Idaho	Chlorinated Hydrocarbons	Statewide	1	Continuous	Not Determinable	E.C.,T.L.C.	Unknown	Computer,Published Papers	5/68
	Organo Phosphates	"	"	Periodic	"	E.C.,T.L.C.,F.P.	"	"	"
Illinois	Chlorinated Hydrocarbons	Statewide	125	Sporadic	250	E.C.,G.C.	Unknown	Unpublished Records	7/74
	Organo Phosphates	"	10	Periodic	120	"	"	Published Papers	7/71
Michigan	Chlorinated Hydrocarbons	Statewide	Variable	Continuous	Variable	G.C.	Unknown	Computer,Published Papers,Unpublished Records	6/71
	Organo Phosphates	"	"	"	"	"	"	"	"
	Triazine Herbicides	"	"	"	"	"	"	"	"
	Phenoxy Herbicides	"	"	"	"	"	"	"	"
	Carbamates	"	"	"	"	"	"	"	"
	Dithiocarbamates	"	"	"	"	"	"	"	"
	Chlorinated Hydrocarbons	Local	10-30	Periodic	3-5	USGS Methods	"	Computer,Published Papers	9/74
	Organo Phosphates	"	"	"	"	"	"	"	"
	Triazine Herbicides	"	"	"	"	"	"	"	"
	Phenoxy Herbicides	"	"	"	"	"	"	"	"
Mississippi	Chlorinated Hydrocarbons	Statewide	Not Determinable	Periodic	Not Determinable	G.L.C.	Unknown	Published Papers	2/69
North Carolina	Chlorinated Hydrocarbons	Statewide	Not Determinable	Periodic	Not Determinable	G.C.	17-42%	Computer	11/73
Oklahoma	Chlorinated Hydrocarbons	Statewide	Unknown	Periodic	Unknown	F.W.P.C.A.	<1PPB	Unpublished Records	--
	Organo Phosphates	"	"	"	"	"	"	"	--
	Phenoxy Herbicides	"	"	"	"	U.S.G.S.	<0.1PPB	"	--

TABLE 49. STATE SOIL MONITORING PROGRAMS

State	Chemical	Coverage	Number of Sites	Sampling Frequency	Samples/Year	Analytical Method	Analytical Precision	Data Storage	Data Range
Colorado	[b]Chlorinated Hydrocarbons	Statewide	Unknown	Continuous/Sporadic	Not Determinable	T.L.C., G.L.C.	PPM	Unpublished Records	6/65
	[b]Organic Phosphates	"	"	"	"	"	"	"	"
	[b]Triazine Herbicides	"	"	"	"	"	"	"	"
	[b]Phenoxy Herbicides	"	"	"	"	"	"	"	"
	[b]Carbamates	"	"	"	"	"	"	"	"
	[b]Dithiocarbamates	"	"	"	"	"	"	"	"
	[b]Dinitroaniline	"	"	"	"	"	"	"	"
Georgia	[a]Chlorinated Hydrocarbons	Statewide	Unknown	Sporadic	15	G.C.	--	Unpublished Records	1/62
	[a]Organo Phosphates	"	"	"	"	"	--	"	"
	[a]Triazine Herbicides	"	"	"	"	"	--	"	"
	[a]Phenoxy Herbicides	"	"	"	"	"	--	"	"
Idaho	Chlorinated Hydrocarbons	Statewide	1	Continuous	3600	E.C., T.L.C.	--	Computer	[illegible]
	Organo Phosphates	"	"	Periodic	1000	"	--	"	5/68-6/74
	Triazine Herbicides	"	"	Sporadic	10	E.C.	--	"	--
	Phenoxy Herbicides	"	"	"	190	"	--	"	--
Mississippi	Chlorinated Hydrocarbons	Statewide	20	Periodic	Not Determinable	G.L.C.	--	Published Papers	2/69
Nevada	Chlorinated Hydrocarbons	Statewide	Not Determinable	Periodic	Not Determinable	G.C.	90%	Unpublished Records	8/71
	Organo Phosphates	"	"	"	"	"	97%	"	"
	Phenoxy Herbicides	"	"	"	"	"	85%	"	"
	Carbamates	"	"	"	"	"	90%	"	"
New York	Chlorinated Hydrocarbons	Statewide	Unknown	Continuous	Not Determinable	F.D.A., P.A.M.	--	Computer	--
	Organo Phosphates	"	"	"	"	"	--	"	--
Utah	Chlorinated Hydrocarbons	Local, Statewide	Unknown	Periodic	Not Determinable	G.L.C.	PPB	Computer	1/68
Wisconsin	Chlorinated Hydrocarbons	Statewide	Unknown	Periodic	Not Determinable	G.L.C.	1PPB	Unpublished Records	6/64
	Organo Phosphates	"	"	"	"	"	10PPB	"	"
	Triazine Herbicides	"	"	Sporadic	"	"	"	"	"
	Phenoxy Herbicides	"	"	"	"	"	"	"	"
	Carbamates	"	"	"	"	"	"	"	"
	Dithiocarbamates	"	"	"	"	CS2 Evolution	0.1PPM	"	"

a = Only on specific request or on a complaint basis

b = Monitored only if commercial applicators are involved

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TABLE [illegible]. STATE WATER MONITORING PROGRAMS

State	Chemical	Coverage	Number of Sites	Sampling Frequency	Samples/Year	Analytical Method	Analytical Precision	Data Storage	Date Began
Arizona	Chlorinated Hydrocarbons	Statewide	Varies	Sporadic	12	G.C.	>10% on most	Unpublished Records	6/69
	Organo Phosphates	"	"	"	"	"	"	"	"
	Phenoxy Herbicides	"	"	"	"	"	"	"	"
Arkansas	Chlorinated Hydrocarbons	Statewide	Non-Fixed	Periodic	Not Determinable	EPA Analytical Methods	>95% on most	Unpublished Records	7/71
	Organo Phosphates	"	"	"	"	"	"	"	"
	Phenoxy Herbicides	"	"	"	"	"	"	"	"
	Carbamates	"	"	"	"	"	"	"	"
	Chlorinated Hydrocarbons	"	102	"	400	G.C.	+20-30% on low	Computer Store ?	3/74
	Organo Phosphates	"	"	"	"	"	"	"	"
	Triazine Herbicides	"	"	"	"	"	"	"	"
	Phenoxy Herbicides	"	"	"	"	"	"	"	"
California	Chlorinated Hydrocarbons	Sacramento-San Joaquin Delta	16	Periodic	40	G.C.	Combined Values	Computer	5/73
	Chlorinated Hydrocarbons	San Joaquin Valley Drainage	23	"	4	"	"	"	9/63
	Organo Phosphates	"	"						1/63
	Chlorinated Hydrocarbons	Statewide	12	"	Varies	"	"	"	10/69
	Organo Phosphates	"	"	"	"	"	"	"	"
Colorado	Chlorinated Hydrocarbons	Statewide	Not Determinable	Once/Year-Fall	Not Determinable	T.L.C.,G.L.C.	PPT	Unpublished	8/71
	^b Organo Phosphates	"	"	"	"	"	"	"	8/63
	^b Triazine Herbicides	"	"	"	"	"	"	"	"
	^b Phenoxy Herbicides	"	"	"	"	"	"	"	"
	^b Carbamates	"	"	"	"	"	"	"	"
	^b Dithiocarbamates	"	Unknown	"	"	"	PPM	"	"
	^b Dinitroaniline	"	"	"	"	"	"	"	"
Connecticut	Dinitroaniline	Statewide	45	Periodic	1/Year	G.C.	--	Computer-Stored(EPA)	7/74
Georgia	^a Chlorinated Hydrocarbons	"	Unknown	Sporadic	25	G.C.	--	Unpublished	1/62
	^a Organo Phosphates	"	"	"	"	"	--	"	"
Idaho	Chlorinated Hydrocarbons	Statewide	1	Continuous	Not Determinable	E.C.,T.L.C.	--	Computer, Published Papers	5/68
	Organo Phosphates	"	"	Periodic	"	E.C.,T.L.C.,F.P.	--	"	5/68-6/70
Illinois	Chlorinated Hydrocarbons	Statewide	125	Sporatic	250	E.C.,G.C.	--	Unpublished Records	7/74
	Chlorinated Hydrocarbons	Lake Michigan & Tributaries	10	Periodic	130	"	--	Published Papers	7/71
Kansas	Chlorinated Hydrocarbons	Statewide	41	Periodic	273	G.C.,E.C.	--	Unpublished Records	12/71
	Organo Phosphates	"	"	"	"	"	--	"	"
Michigan	Chlorinated Hydrocarbons	Statewide	Varies	Continuous	Varies	G.C.	--	Computer, Published Papers	6/71
	Organo Phosphates	"	"	"	"	"	--	"	"
	Triazine Herbicides	"	"	"	"	"	--	"	"
	Phenoxy Herbicides	"	"	"	"	"	--	"	"
	Carbamates	"	"	"	"	"	--	"	"
	Dithiocarbamates	"	"	"	"	"	--	"	"
	Dinitroaniline	"	"	"	"	"	--	"	"
	Chlorinated Hydrocarbons	Upper St. Joseph	10-30	Periodic	3-5	Std. USGS Methods	--	Computer, Published Papers	9/74
	Organo Phosphates	"	"	"	"	"	--	"	"
	Triazine Herbicides	"	"	"	"	"	--	"	"
	Phenoxy Herbicides	"	"	"	"	"	--	"	"
Minnesota	Chlorinated Hydrocarbons	Statewide	103	Periodic	206/Year	G.C.	.01PPB	Computer	1/60
Mississippi	Chlorinated Hydrocarbons	Statewide	Not Determinable	Periodic	Not Determinable	G.L.C.	--	Published Papers	2/69
Nevada	Chlorinated Hydrocarbons	Statewide	Not Determinable	Periodic	Not Determinable	G.C.	96%	Unpublished Records	8/71
	Organo Phosphates	"	"	"	"	"	97%	"	"
	Phenoxy Herbicides	"	"	"	"	"	83%	"	"
	Carbamates	"	"	"	"	"	90%		
North Carolina	Chlorinated Hydrocarbons	Statewide	33	Periodic	99	G.C.	17-42%	Computer	11/7
Ohio	Chlorinated Hydrocarbons	Statewide	76	Periodic	416	G.C.	[illegible]	Computer	4/73
Oklahoma	^c Chlorinated Hydrocarbons	Statewide	Unknown	Periodic	Unknown	F.W.P.C.A.	1PPB	Unpublished Records	--
	^c Organo Phosphates	"	"	"	"	"	"	"	--
	Phenoxy Herbicides	"	"	Sporadic	"	U.S.G.S.	"	"	--
	Chlorinated Hydrocarbons	"	1040	"	30	G.C.	+20-10%	Computer	2/73
	Organo Phosphates	"	"	"	"	"	"	"	"
Rhode Island	Chlorinated Hydrocarbons	Statewide	Unknown	Continuous	195	F.W.P.C.A.	--	Unpublished Records	8/72
	Organo Phosphates	"	"	Sporadic	10	"	--	"	8/73
	Carbamates	"	"	"	20	"	--	"	"
South Carolina	Chlorinated Hydrocarbons	Statewide	Unknown	Periodic	Unknown	G.C.	--	Computer	--
	Organo Phosphates	"	"	"	"	"	--	"	--
Utah	Chlorinated Hydrocarbons	Statewide	Unknown	Periodic	Not Determinable	G.L.C.	PPB	Computer	1/68
Virginia	Chlorinated Hydrocarbons	Statewide	100	Periodic	200	G.C.	--	Unpublished Records	1/73
	Organo Phosphates	"	"	"	"	"	--	"	"
	Dinitroaniline	"	"	"	"	"	--	"	"

a = Only on specific request or on a complaint basis
b = Monitored only if commercial applicators are involved
c = Done in response to suspected problems

TABLE 51. MISCELLANEOUS STATE MONITORING PROGRAMS

Medium	State	Chemical	Coverage	Number of Sites	Sampling Frequency	Samples/Year	Analytical Methods	Analytical Procedure	Data Storage	Date Began
Marine Water	California	Chlorinated Hydrocarbons	Local	16	Periodic	48	G.C.	Unknown	Computer	3/73
	Connecticut	Dinitroaniline	Statewide	45	Periodic	1	G.C.	Unknown	Computer	7/76
	Delaware	Organo Phosphates	Statewide	Unknown	Sporadic	Unknown	Unknown	Unknown	Published Papers, Unpublished Records	--
	North Carolina	Chlorinated Hydrocarbons	Statewide	33	Periodic	99	G.C.	17-42%	Computer	11/73
	Virginia	Chlorinated Hydrocarbons	Statewide	100	Periodic	200	G.C.	Unknown	Unpublished Records	1/73
		Organo Phosphates	"	"	"	"	"	"	"	"
		Dinitroaniline	"	"	"	"	"	"	"	"
Man	Arkansas	Organo Phosphates	Local, Statewide	Non-Fixed	Periodic, Sporadic	Not Determinable	EPA Methods	795%	Unpublished Records	7/71
	Idaho	Chlorinated Hydrocarbons	Statewide	Unknown	Continuous	Not Determinable	E.C.,T.L.C.	Unknown	Computer,Published Papers	5/68
		Organo Phosphates	"	"	Periodic	"	E.C.,T.L.C.,F.P.	"	"	"
Agricultural Drainage	California	Chlorinated Hydrocarbons	Regional	23	Periodic	4	G.C.	Unknown	Computer,Published Papers	9/63
		Organo Phosphates	"	"	"	"	"	"	"	"
Sewage	Colorado	Chlorinated Hydrocarbons	Statewide	Not Determinable	Continuous, Sporadic	Not Determinable	T.L.C.,G.L.C.	PPM	Unpublished Records	8/65
		Organo Phosphates	"	"	"	"	"	"	"	"
		Triazine Herbicides	"	"	"	"	"	"	"	"
		Phenoxy Herbicides	"	"	"	"	"	"	"	"
		Carbamates	"	"	"	"	"	"	"	"
		Dithiocarbamates	"	"	"	"	"	"	"	"
		Dinitroaniline	"	"	"	"	"	"	"	"
	Idaho	Chlorinated Hydrocarbons	Statewide	Not Determinable	Continuous	Not Determinable	E.C.,T.L.C.	Unknown	Computer,Published Papers	5/68
		Organo Phosphates	"	"	Periodic	"	E.C.,T.L.C.,F.P.	"	"	"
	Illinois	Chlorinated Hydrocarbons	Local	Not Determinable	Periodic	Not Determinable	G.C.	Unknown	Published Papers	7/71
	Michigan	Chlorinated Hydrocarbons	Statewide	Not Determinable	Continuous	Not Determinable	G.C.	Unknown	Computer,Published Papers,Unpublished Records	6/71
		Organo Phosphates	"	"	"	"	"	"	"	"
		Triazine Herbicides	"	"	"	"	"	"	"	"
		Phenoxy Herbicides	"	"	"	"	"	"	"	"
		Carbamates	"	"	"	"	"	"	"	"
		Dithiocarbamates	"	"	"	"	"	"	"	"
		Dinitroaniline	"	"	"	"	"	"	"	"
	Oklahoma	Chlorinated Hydrocarbons	Statewide	Not Determinable	Sporadic	Not Determinable	G.C.	+0%-10%	Computer	2/73
		Organo Phosphates	"	"	"	"	"	"	"	"
	Utah	Chlorinated Hydrocarbons	Local, Statewide	Unknown	Periodic	Not Determinable	G.L.C.	PPB	Computer,Unpublished Records	1/68

It can be seen that there is an apparent abundance of state-collected data on environmental pesticide residue levels. Over one-half of the conterminous states are involved to some degree in monitoring residue levels in environmental components of interest to the NPMP. What this means to the NPMP, however, is a matter of conjecture due to the superficial nature of the information available on these programs. Some brief comments, however, can be made relative to the NPMP.

In general, the data suggest that each state is planning and executing its own monitoring programs on the basis of its particular needs. These programs would also be influenced by many of the same constraints which affect monitoring programs at the national level (i.e.—budget, manpower, changing priorities, etc.). Consequently, it is felt that many of the same comments made relative to the national programs (Chapter 4) would also apply to the state monitoring programs. They would, however, be compounded due to the absence of a single focal point, such as the Monitoring Panel of the Federal Working Group on Pest Management. Such a focal point is important from the standpoint of maintaining some degree of awareness and influence concerning the broad spectrum of monitoring activities and their resulting data.

While some states employ computerized storage of their monitoring data, the majority of the data apparently is maintained in the form of unpublished records residing in the files of the responsible agency. Even though identified as to the source of the data (i.e.—state agency), this fact could cause sizable problems in efficiently obtaining the data and in the ability to discriminate among important and unimportant data.

Many of the state monitoring programs are of relatively recent beginnings, and reflect some of the same concerns as the NPMP. However, monitoring and surveillance activities concerning regulation, enforcement, compliance with standards, and responses to specific compliants are much in evidence at the state level. Thus, the value of these data relative to augmenting the NPMP in establishing baseline residue levels and determining trends in these levels is questionable. Moreover, even where the NPMP and a particular state are monitoring the same environmental component, differences in sampling locations, sample collection techniques and analytical methodologies would preclude any direct comparison of results.

In general, very little could be ascertained from the available survey data as to the specifics of the design and operation of state monitoring programs. A review of the state programs suggests that the currently available state data would be of little value for augmenting the developing NPMP data base. The establishment of baseline residue levels and detection of changes in these levels require the development and adherence to an experimental design capable of providing statistically valid data over long time frames of operation. Such designs are apparently lacking at the level of state monitoring programs. For example, sampling frequencies range from continuous to sporadic, periodic or unknown. Likewise, number of sites and samples taken per year range from fixed numbers to unknown, non-fixed, and not determinable. Moreover, even where the NPMP and a particular state are monitoring the same environmental component, differences in sampling locations, sample collection techniques, and analytical methodologies would preclude any direct comparison of results.

Perhaps the greatest value of the state obtained residue data with respect to NPMP operations would fall in the arena of problem area definition. The NPMP can recognize problem areas at a national level. However, a detailed assessment of the problem area requires a monitoring system operating at a more localized level, and thus, more aligned to obtaining the detailed data necessary to refine the extent and definition of the particular problem area. The state operations would be particularly amenable to such data gathering efforts on a case by case basis. Moreover, such an approach is consistent with the National Pesticide Monitoring Plan currently being drafted by the EPA. This plan proposes to use state monitoring programs as part of a nested monitoring scheme.

The need for rigid quality control in the aforementioned program, due to the many agencies and laboratories involved, has been recognized. Thus, the plan calls for the various EPA Regional Offices to assist the states in designing and implementing their programs. Also, the Monitoring Panel of the Federal Working Group on Pest Management has recently published a set of guidelines for sampling and analytical methodologies for ambient pesticide monitoring. Such efforts which strive to bring a degree of standardization to pesticide monitoring activities are necessary to enhance the comparability of residue data collected by the numerous agencies concerned with pesticides in the environment.

CHAPTER 6. POLICY OPTIONS

INTRODUCTION

The NPMP has been in various stages of development since 1964 and is considered an integral part of the Federal government's efforts for addressing the subject of pesticide residue levels in the environment. However, the variation among subprogram objectives, the variation in priorities of the data collecting agencies, the occasional curtailnent of monitoring activities due to resource constraints, and the apparent lack of subprogram continuity and accountability suggest that the NPMP is not adequately addressing the charge of the Federal Environmental Pesticide Control Act of 1972. As a result, the Environmental Protection Agency charged BCL to assess the effectiveness of the NPMP and to discuss the implications of project findings with respect to policy options available to the government for improving pesticide monitoring capability. The purpose of this section is to identify and discuss those policy options BCL considers realistic for improving the pesticide monitoring capability of the NPMP.

Key project findings (Chapters 3, 4, and 5), indicate lack of management accountability and lack of operational continuity in the current NPMP. At present, each subprogram manager is responsible for interpreting the objectives of the NPMP, structuring monitoring designs, maintaining analytical quality, and reporting the collected data for his portion of the program. Since each subprogram manager is responsible to the particular agency by which he is employed, and since there is no coordinating group with overall NPMP management responsibilities and authority, program continuity and accountability do not -- and, indeed, cannot be expected to -- exist.

The Federal Working Group on Pest Management (FWGPM) attempts to review and coordinate pesticide monitoring aciivities by providing a forum in which methodologies and program findings can be discussed. However, since the FWGPM has no authority to establish objectives or to insure data quality, it cannot now provide the necessary program management for pesticide monitoring. Definitive policy or monitoring option responsibility reamins with each subprogram manager.

As a result of the parallel but separate management systems associated with the NPMP, subprogram operational continuity has, in some cases, suffered. Project findings indicate that the subprograms in general are subject to the objectives, funding, and data priorities of the agencies which operate the subprograms (several of the subprograms are jointly funded by EPA and other agencies). In effect, each agency designs and operates its own monitoring program independent of other subprogram elements. Since there is no NPMP experimental design or overall management, such a situation is basically unavoidable. In addition, the decision as to whether or not subprogram objectives fit NPMP objectives, the decision to change a monitoring design, and the decision on what chemicals are monitored are essentially left in the hands of each subprogram manager. For example, the Human Monitoring Program has been redesigned three times since its creation in 1965. Also, an experimental design for assessing pesticide residues in water was not developed until 1971; it was redesigned in 1973, and data will not be available until 1975. Even though the design changes have improved both of these programs, such modifications indicate that there is a definite need for both accountable NPMP management and a NPMP experimental design.

While BCL's primary emphasis was directed toward the existing NPMP, it became obvious that any attempt to define realistic policy options for improving pesticide monitoring capability would have to recognize the charge of Section 20, Public Law 92-516. This section 20 of the Federal Environmental Pesticide Control Act of 1972 states that

> SEC. 20. RESEARCH AND MONITORING.
>
> (a) Research. The Administrator shall undertake research, including research by grant or contract with other Federal agencies, universities, or others as may be necessary to carry out the purposes of this Act, and he shall give priority to research to develop biologically integrated alternatives for pest control. The Administrator shall also take care to insure that such research does not duplicate research being undertaken by any other Federal agency.

(b) National Monitoring Plan.--The Administrator shall formulate and periodically revise, in cooperation with other Federal, State, or local agencies, a national plan for monitoring pesticides.

(c) Monitoring.--The Administrator shall undertake such monitoring activities, including but not limited to monitoring in air, soil, water, man, plants, and animals, as may be necessary for the implementation of this Act and of the national pesticide monitoring plan. Such activities shall be carried out in cooperation with other Federal, State, and local agencies.

As stated here, EPA is charged with integrating pesticide research and pesticide monitoring such that a viable, realistic National Monitoring Plan can be formulated and used to monitor environmental pesticide residue levels.

Using both the findings of this research project and the charge of Section 20 of the Act, BCL has identified three potential policy options available to the Government for improving pesticide monitoring capability. While an unlimited number of options exist, of course, BCL believes that the following three embody a reasonable range of the important considerations:

(1) The NPMP subprogram managers should continue to update and redesign their component programs as they each judge necessary.

(2) The Federal Working Group on Pest Management should be given management authority for the NPMP.

(3) EPA should assume all NPMP management responsibilities.

Each policy option is discussed separately.

Policy Option 1: The NPMP Subprogram Managers Should Continue to Update and Redesign Their Component Programs As They Each Judge Necessary

The following considerations support this policy option as a viable alternative:

(1) Project findings indicate several subprograms have been redesigned such that they more adequately address the objectives of the NPMP.

(2) Subprogram managers are familiar with the funding and management requirements of their respective programs and have established relationships with field and analytical personnel.

(3) The subprograms external to EPA represent Departments which are involved in pesticide activities. Such an arrangement is in keeping with the charge of Section 20 of PL 92-516.

(4) Most of the existing subprogram managers are members of (or communicate with) the Pesticide Monitoring Panel of the Federal Working Group on Pest Management. As such, they are exposed to the priorities and problems peculiar to each subprogram of the NPMP.

(5) Under the current management structure, each subprogram manager can redesign his program with a minimum of "red-tape". This arrangement guarantees a maximum amount of freedom to react to new problem areas.

(6) Policy Option 1 will not require EPA to deal with the significant problems inherent in any major program reorganization (i.e., additional funding, additional man-power, interagency coordination or agreements, etc.).

However, there are several reasons why Policy Option 1 would not likely improve the overall pesticide monitoring capability of the NPMP and address the charge of Public Law 92-516. The reasons are as follows:

(1) A single, accountable management structure for the NPMP does not exist. Project findings (Chapters 3 and 4) indicated that the lack of accountable management is one of the major shortcomings of the NPMP. Policy Option 1 will not rectify this situation.

(2) An experimental design for a National Pesticide Monitoring Program does not exist. There is a charge (Section 20, PL 92-516) and a set of objectives (NPMP) for an experimental design, but as yet it does not

exist. As a result, NPMP continuity, as well as the ability to collect and integrate data from the subprograms, has suffered, and will continue to suffer until such a design is structured. Policy Option 1 will not furnish an organization which could develop, authoritatively implement, and operate a national experimental design for the NPMP.

(3) Although several subprograms have been redesigned to more adequately address the objectives of the NPMP, such action only took place where EPA was in complete control (Human and Estuarine Programs) or arranged partial funding responsibility (Water Program). Under Policy Option 1, control of the non-EPA funded programs remains subject to the funding and goal priorities of the host Department.

(4) Since the Federal Working Group on Pest Management has no management or quality control authority, it has been unable to fully coordinate the activities of the various subprograms. Policy Option 1 will not address this problem area.

(5) Public Law 92-516 charges EPA to accept the responsibility of being the focal point for pesticide research and pesticide monitoring. Under Policy Option 1, no mechanism is available to EPA for addressing this charge.

Policy Option 2: The Federal Working Group on Pest Management Should Be Given Management Authority for the NPMP

Pesticide monitoring capabilities could be improved by delegating NPMP management authority to the Federal Working Group on Pest Management (FWGPM):

(1) While the Administrator of the EPA is charged by Public Law 92-516 to develop a National Pesticide Monitoring Plan, the development of the Plan has

actually been guided by the philosophy and activities of the FWGPM. BCL interprets this action as evidence of EPA's willingness to comply with the philosophy as well as the charge of Public Law 92-516.

(2) The FWGPM is the primary federal coordinating mechanism for interagency activities concerning pesticides and pest management. By working with the FWGPM, EPA will be able to utilize existing lines of communication rather than trying to establish a separate but parallel mechanism for coordinating the activities of Departments involved in pesticide research and monitoring.

(3) The FWGPM has a technical advisory group -- The Pesticide Monitoring Panel -- which has been directly involved with the evolution of the NPMP. Many of the subprogram directors are members of the Pesticide Monitoring Panel; as such, they are aware of the problems associated with developing accountable management and developing an NPMP experimental design.

(4) Another FWGPM technical advisory group -- The Pesticide Research Panel -- could, if so charged, interact with the Pesticide Monitoring Panel to establish realistic monitoring goals. This panel could also assist in standardizing analytical techniques and identifying environmental sinks.

(5) Communication between the Office of Pesticide Programs (EPA) and the FWGPM have already been established.

(6) Each subprogram would continue to be responsible for collecting, analyzing, and presenting data.

(7) The FWGPM would be responsible for NPMP management, design, and quality control; EPA would not have to expand staff responsibilities or add staff members for these functions.

While the aforementioned benefits are real and worthy of serious consideration, there are also some constraints associated with Policy Option 2:

(1) Section 20, Public Law 92-516 charges the Administrator of EPA with undertaking pesticide research, developing a National Monitoring Plan, and conducting monitoring activities in various components of the environment. While the Administrator is directed to coordinate EPA's activities with other agencies involved in pesticide activities it would seem that EPA is still responsible to the Congress for fulfilling the charge of Public Law 92-516. Also, the charter of the FWGPM specifically states that "In no case, however, will the Federal Working Group supercede the responsibility of each agency to carry out the functions assigned to it by legislative and executive mandates." Therefore, there is some doubt as to whether or not EPA could delegate NPMP management responsibility to the FWGPM.

(2) If management authority is given to the FWGPM, EPA would be bound to monitoring guidelines and standards established by the FWGPM. EPA is represented in the FWGPM and would therefore have a voice in determining such guidelines and standards, but ultimate control would reside with the FWGPM.

(3) Since the FWGPM reports to the Council on Environmental Quality (CEQ), EPA would have to reach agreement with CEQ before the FWGPM could assume NPMP management responsiblity. In fact, the lines of communication would have to be clarified in the agreement between EPA and CEQ.

(4) The FWGPM does not now have the manpower or the funds to provide full management for the NPMP. Before the FWGPM could assume NPMP management responsibilities, interagency agreements would have to be established between all Departments and Agencies now conducting pesticide monitoring and the FWGPM. The agreements would be needed to insure that all participants would furnish sufficient funds and manpower to FWGPM to manage the NPMP. Alternatively, such funds would have to be provided by Congress through the CEQ. NPMP management would involve the FWGPM as well as its technical advisory panels.

(5) The FWGPM, through its Pesticide Monitoring Panel, has been coordinating the activities of NPMP monitoring since 1969. During this time, no apparent effort has been made to structure a comprehensive experimental design for the NPMP. Because of the FWGPM's advisory position, BCL can understand why authoritative action has not occurred. If NPMP management responsibility were delegated to the FWGPM, development, implementation, and management of an effective experimental design for the NPMP will likely require a commitment and effort beyond that which could be provided by a part-time management/advisory body such as the FWGPM.

(6) By its very nature and charge, the FWGPM is not an action agency--it is an advisory body. BCL submits that such problems as program funding, manpower allocations, experimental design, management accountability, program continuity, data quality, and research/monitoring interaction can only be handled by an action agency.

(7) Delegating its responsibilities to a non-action body could damage EPA's credibility with the public, and the Congress.

Policy Option 3. EPA Should Assume All NPMP Management Responsibilities

BCL considers Policy Option 3 as the most realistic for fulfilling the charge of Public Law 92-516 and for addressing the project findings relative to improving NPMP capabilities. Factors supporting this conclusion include:

(1) The Administrator of EPA has been directed by Congress to undertake pesticide monitoring activities. Although Public Law 92-516 states that "monitoring shall be carried out in cooperation with other Federal, State, and Local agencies", EPA is still accountable for pesticide monitoring activities.

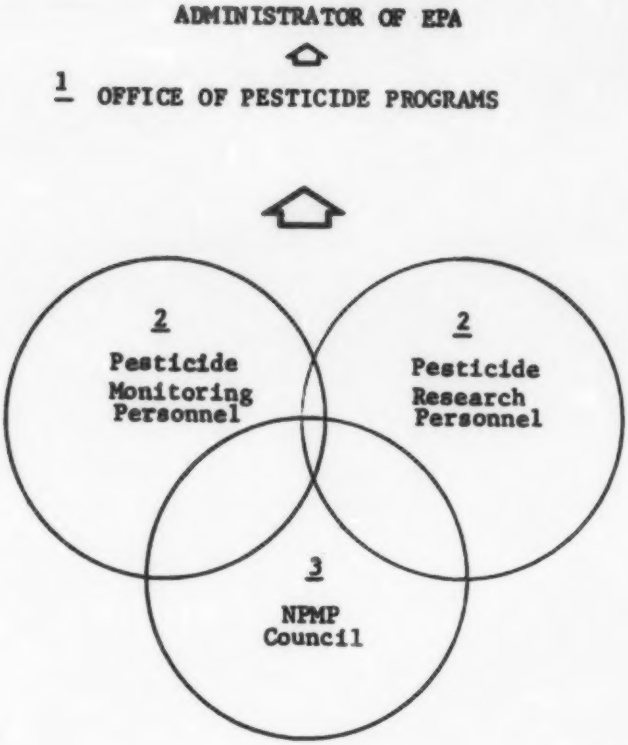
(2) EPA is developing a National Monitoring Plan for pesticides. The third draft of the Plan (EPA-1975) calls for the utilization of existing NPMP data to satisfy stated objectives. Project findings indicate that current NPMP data and operating techniques are not suitable to fully address the EPA objectives. BCL submits that before an effective National Monitoring Plan can be implemented, EPA must be in a position to insure NPMP data quality and reliability.

(3) Project findings indicate that NPMP capabilities would be improved by establishing accountable NPMP management and by formulating an NPMP experimental design. EPA is an action agency; thus it has the manpower, funds, capability, and responsibility to establish both an NPMP experimental design and accountable NPMP management.

(4) EPA can assume NPMP management responsibility as well as coordinate NPMP activities with other Federal, State, and Local agencies through the use of interagency agreements and continued advisory participation of the FWGPM.

While BCL contends that the most effective way EPA can increase the capabilities of the NPMP is to assume total management responsibility, the feasibility of such an action must be considered. BCL's rationale and a pathway by which EPA could increase the monitoring capabilities of NPMP and address the charge of Public Law 92-516 by this action is as follows.

It is unrealistic to think that EPA could or should assume all pesticide monitoring activities currently being addressed by the various Federal Departments. However, EPA can marshall the inhouse capabilities necessary to determine the data required to address Public Law 92-516 and the means of acquiring those data. Such an arrangement would insure that pesticide research and pesticide monitoring would be properly integrated so that a National Monitoring Plan would address necessary and obtainable goals. A suggested management and information flow scheme is as follows:


ADMINISTRATOR OF EPA
1 OFFICE OF PESTICIDE PROGRAMS
2 Pesticide Monitoring Personnel
2 Pesticide Research Personnel
3 NPMP Council

Note: The above circles do not imply a management structure for the Office of Pesticide Programs; the circles are used to indicate the expertise and interrelationships necessary for effective NPMP management.

(1) The Deputy Assistant Administrator, Office of Pesticide Programs, would be charged with the responsibility for NPMP management. Such responsibility would insure that NPMP activities would be coordinated with existing EPA pesticide programs, both within and outside OPP.

(2) EPA personnel responsible for pesticide monitoring and pesticide research should interact closely so that realistic monitoring goals (expressed in an NPMP experimental design) can be established.

(3) Representatives from the pesticide research and pesticide monitoring groups could then function as an NPMP Council. The Council would provide management for the NPMP and would be accountable to the Deputy Assistant Administrator, Office of Pesticide Programs.

Such a management structure would insure that:

(1) Accountability for the NPMP would be established within the Office of Pesticide Programs.

(2) Both monitoring and research personnel would be represented in the NPMP Council - a situation which would encourage the formulation of a realistic NPMP experimental design and provide NPMP continuity.

(3) A mechanism for improving cooperation between EPA research and monitoring personnel would be established. Such cooperation would insure that EPA could continue to update the proposed NPMP experimental design to reflect the best sampling techniques and analytical methodologies available without destroying program continuity.

(4) The NPMP Council would provide the necessary focal point for NPMP monitoring activities. Such a focal point is vital if the Pesticide Hazard Evaluation System proposed by the Office of Pesticides Programs is to utilize NPMP data.

BCL has been unable to identify any real limitations to Policy Option 3. However, before EPA could effectively implement an NPMP experimental design, determine a rationale for what pesticides to monitor, and establish quality control for analytical techniques, agreements between EPA and other Departments involved in NPMP activities would have to be established. It is unrealistic to assume that non-EPA monitoring programs would be redesigned just to fulfill EPA's data requirements (if such change is warranted).

Two mechanisms are available to EPA for coordinating NPMP management with other Federal Departments concerned with pesticide monitoring and research:

(1) The suggested EPA/NPMP Council should continue EPA's interaction with the FWGPM since the FWGPM is the primary coordinating mechanism for interagency activities concerning pesticides and pest management. Interaction could be provided directly by members of the NPMP Council or through the designated representative from the Office of Pesticide Programs.

(2) The Office of Pesticide Programs could initiate interagency agreements with non-EPA Departments involved in pesticide research and monitoring. Such agreements would (a) insure that the data required by the Pesticide Council for NPMP activities would be provided, (b) coordinate NPMP data requirements with existing programs, and (c) provide for NPMP continuity.

Since such interagency agreements already exist for several NPMP subprograms, BCL does not consider additional agreements to be a serious limitation for Policy Option 3.

REFERENCES

Andrilenas, P. A. 1974. Farmers' Use of Pesticides in 1971 - Quantities. U. S. Department of Agriculture, Economic Research Service. Agricultural Economic Report No. 252.

Bailey, G. W., A. P. Barnett, W. R. Payne, Jr., and C. N. Smith. 1974. Herbicide Runoff From Four Coastal Plain Soil Types. National Environmental Research Center, Office of Research and Monitoring Report EPA-660/2-74-017. U. S. Environmental Protection Agency, Corevallis, Oregon. 99 pp.

Belisle, A. A., W. L. Reichel, L. N. Loche, T. G. Lamont, B. M. Mulhern, R. M. Prouty, R. B. DeWolf, and E. Cromartie. 1972. Residues of Organochlorine Pesticides, Polychlorinated Biphenyls, and Mercury and Autopsy Data for Bold Eagles, 1969 and 1970. Pesticide Monitoring Journal 6(3):133-138.

Berger, B. L. 1974. National Fish Monitoring Program. Bureau of Sport Fisheries and Wildlife. Personal Communication.

Breidenbach, A. W., C. G. Gunnerson, F. K. Kawahara, J. J. Lichtenberg, and R. S. Green. 1967. Chlorinated Hydrocarbon Pesticides in Major River Basins, 1957-1965. Public Health Report 82(2):139-156.

Buffington, J. D. 1974. Assessment of Ecological Consequences of Herbicide Use Along Transmission Line Rights-of-Way and Recommendations for Such Use. Argonne National Laboratory Report No. ANL/ES-34. Argonne, Illinois. 44 pp.

Butler, P. A. 1972. Data supplied to Battelle's Columbus Laboratories.

Butler, P. A. 1973. Organochlorine Residues in Estuarine Mollusks 1965-73 - National Pesticide Monitoring Program. Pesticide Monitoring Journal 6(4): 238-362.

Butler, P. A. 1974. National Estuarine Monitoring Program. Gulf Breeze Environmental Research Laboratory, EPA. Personal Communication.

Carey, A. 1974. National Soils Monitoring Program, EPA. Personal Communication.

Corneliussen, P. E. 1969. Residues in Food and Feed, Pesticide Residues in Total Diet Samples (IV). Pesticide Monitoring Journal 2(4):140-152.

Corneliussen, P. E. 1970. Residues in Food and Feed, Pesticide Residues in Total Diet Samples (V). Pesticide Monitoring Journal 4(3):89-105.

Corneliussen, P. E. 1972. Residues in Food and Feed, Pesticide Residues in Total Diet Samples (VI). Pesticide Monitoring Journal 5(4):313-330.

Corneliussen, P. 1974. National Food and Feed Monitoring Program, FDA. Personal Communication.

REFERENCES
(Continued)

Crawford, N. H. and A. S. Donigian, Jr. 1973. Pesticide Transport and Runoff Model for Agriculture. Office of Research and Development Document EPA 660/2/74-013. Environmental Protection Agency, Washington, D. C. 213 pp.

Crockett, A. B., G. B. Wiersma, H. Tai, W. G. Mitchell and P. J. Sand. National Soils Monitoring Program for Pesticide Residues - FY 1970. Published by the U. S. Environmental Protection Agency. Washington, D. C.

Crockett, A. B. 1974. Ecological Monitoring Branch, Office of Pesticide Programs, Environmental Protection Agency. Personnal Communication.

Dindal, D. L. and T. J. Peterle. 1968. Wing and Body Tissue Relationships of DDT and Metabolite Residues in Mallard and Lesser Scaup Ducks. Bull. Environ. Contamination Toxicol. 3:37-48.

Duggan, R. E., H. C. Barry, and L. T. Johnson. 1967. Residues in Food and Feed, Pesticide Residues in Total Diet Samples (II). Pesticide Monitoring Journal 1(2):2-12.

Duggan, R. E., G. Q. Lipscomb, E. L. Cope, R. E. Heatwole and R. C. Kling. 1971. Pesticide Residue Levels in Foods in the United States from July 1, 1963 to June 30, 1969. Pesticide Monitoring Journal 5(2):73-212.

Duggan, R. E. and H. R. Cook. 1971. National Food and Feed Monitoring Program. Pesticide Monitoring Journal 5(1):37-43.

Dustman, E. H., W. E. Martin, R. G. Heath, and W. L. Reichel. 1971. Monitoring Pesticides in Wildlife. Pesticides Monitoring Journal 5(1):50-52.

Environmental Protection Agency. 1974. Strategy of the Environmental Protection Agency for Controlling the Adverse Effects of Pesticides. Office of Pesticide Programs, Office of Water and Hazardous Materials, Environmental Protection Agency.

Feltz, H. R., W. T. Sayers, and H. P. Nicholson. 1971. National Monitoring Program for the Assessment of Pesticide Residues in Water. Pesticide Monitoring Journal 5(1):54-62.

Feltz, H. 1974. National Water Monitoring Program, EPA. Personal Communication.

Heath, R. G. and R. M. Prouty. 1967. Trial Monitoring of Pesticides in Wings of Mallards and Black Ducks. Bull, Environ. Contamination Toxicol. 2:101-110.

Heath, R. G. 1969. Nationwide residues of organochlorine pesticides in wings of mallards and black ducks. Pesticide Monitoring Journal 3(2):115-123.

REFERENCES
(Continued)

Heath, R. G. and S. A. Hill. 1974. Nationalwide Organochlorine and Mercury Residues in Wings of Adult Mallards and Black Ducks During the 1969-70 Hunting Season. Pesticides Monitoring Journal. 3:153-164.

Henderson, C., W. L. Johnson and A. Inglis. 1969. Organochlorine Insecticide Residues in Fish (National Pesticide Monitoring Program). Pesticide Monitoring Journal 3(3):145-171.

Henderson, C., A. Inglis, and W. L. Johnson. 1971. Organochlorine Insecticide Residues in Fish-Fall 1969, National Pesticide Monitoring Program. Pesticide Monitoring Journal 5(1):1-11.

Henderson, C., A. Inglis, and W. L. Johnson. 1972. Mercury Residues in Fish, 1969-1970 - National Pesticides Monitoring Program. Pesticide Monitoring Journal 6(3):144-159.

Inglis, A., C. Henderson, and W. L. Johnson. 1971. Expanded Program for Pesticide Monitoring of Fish. Pesticides Monitoring Journal 5(1):47-49.

Irving, G. W., Jr. 1970. Agricultural Pest Control and The Environment. Science 168:1419-1424.

Johnson, R. E., T. C. Carver and E. H. Dustman. 1967. Indicator Species Near Top of Food Chain Chosen For Assessment of Pesticide Base Levels in Fish and Wildlife - Clams, Oysters, and Sediment in Estuarine Environment. Pesticide Monitoring Journal 1(1):7-13).

Johnson, R. E., T. C. Carver and E. H. Dustman. 1967. Residues in Fish, Wildlife, and Estuaries, Pesticides Monitoring Journal. 1:7-13.

Kortright, F. H. 1967. The Ducks, Geese, and Swans of North America. The Stackpole Company. Harrisburg, P. A. 476 pp.

Krenkel, P. A., R. S. Reimers, and W. D. Burrows. 1973. Mechanisms of Mercury Transformations in Bottom Sediments - Part 1 - Final Report. Technical Report No. 31, Environmental and Water Resources Engineering. Vanderbilt University, Nashville, Tennessee.

Kutz, F. 1974. National Human Monitoring Program, EPA. Personal Communication.

Lawless, E. W., R. Rumker, And T. L. Ferguson. 1972. The Pollution Potential in Pesticide Manufacturing. Environmental Protection Agency, Office of Water Programs, Applied Technology Division. NTIS PB-213 782.

Lichtenberg, J. U., J. W. Eichelberger, R. C. Dressman, and J. E. Longbottom. 1970. Pesticides in Surface Waters of the United States - A 5-Year Summary, 1964-1968. Pesticides Monitoring Journal 4(2):71-86.

REFERENCES (Continued)

Lowe, J. I., P. D. Wilson, A. J. Rick and A. J. Wilson, Jr. 1971. Chronic Exposure of Oysters to DDT, Toxaphene and Parathon. Proceedings of the National Shellfisheries. Assoc. 61:71-79.

Manigold D. 1974. National Water Monitoring Program, Denver Research Center, USGS. Personal Communication.

Martin, W. E. 1969. Organochlorine Insecticide Residues in Starlings. Pesticides Monitoring Journal. 3:102-114.

Martin, R. J. and R. E. Duggan. 1968. Pesticide Residues in Total Diet Samples (III). Pesticide Monitoring Journal 1(4):11-20.

Martin, W. E. 1972. Mercury and Lead Residues in Starlings - 1970. Pesticide Monitoring Journal 6(1):27-32.

Martin, W. E. and P. R. Nickerson. 1973. Mercury, Lead, Cadmium, and Arsenic Residues in Starlings - 1971. Pesticide Monitoring Journal 7(1): 67-72.

Martin, W. E. and P. R. Nickerson. 1972. Organochlorine Residues in Starlings - 1970. Pesticide Monitoring Journal. 6(1):33-40.

Malhern, B. M., W. L. Reichel, L. N. Locke, T. G. Lamont, A. Belisle, E. Cromartie, G. E. Bagley, and R. M. Prouty. 1970. Organochlorine Residues and Autopsy Data From Bald Eagles 1966-1968. Pesticide Monitoring Journal 4(3):141-144.

Nickerson, P. R. 1974. Unpublished data supplied to Battelle's-Columbus Laboratories.

Panel on Pesticide Monitoring, Working Group on Pesticides. 1971. Criteria For Defining Pesticide Levels to be Considered an Alert to Potential Problems. Pesticide Monitoring Journal 5(1):36.

Pesticide Monitoring Journal. 1967. National Pesticide Monitoring Sites - 1967. Pesticide Monitoring Journal 1(1):8-9.

Pesticide Monitoring Journal. 1968. Residues in Food and Feed, Pesticide Residue Levels in Foods in the United States From July 1, 1963 to June 30, 1967. Pesticide Monitoring Journal 2(1):2-45.

Reichel, W. L., E. C. Romartie, T. C. Lamont, B. M. Nulhein and R. M. Prouty. 1969. Pesticide Residues in Eagles. Pesticides Monitoring Journal 3:142-144.

REFERENCES
(Continued)

Reimers, R. S., W. D. Burrows, and P. A. Krenkel. 1973. Total Mercury Analysis: Review and Critique. Journal Water Pollution Control Federation 45(5):814-828.

Sand, P. F., J. W. Gentry, J. Bongherg, and M. S. Schecter. 1967. National Soil Monitoring Program Studies of High-, Low-, and Non-Use Areas. Pesticide Monitoring Journal 1:16-19.

Schulze, J. A., D. B. Marigold, and F. L. Andrews. 1973. Pesticides in Selected Western Streams - 1968-1971. Pesticides Monitoring Journal 7(1):73-84.

Spencer, D. A. 1974. The National Pesticide Monitoring Program - An Overview of th First 10 Years of the Program's Operation. Published by the National Agricultural Chemicals Association. Washington, D. C.

Sprunt, A. IV and H. S. Zim. 1961. Gamebirds - A Guide to North American Species and Their Habits. Golden Press. New York, New York. 160 pp.

Steel, G. D. and J. H. Torrie. 1960. Principles and Procedures of Statistics. McGraw-Hill. New York, New York. 481 pp.

Stevens, L. J., C. W. Collier, and D. W. Woodham. 1970. Monitoring Pesticides in Soils from Areas of Regular, Limited, and No Pesticide Use. Pesticide Monitoring Journal 4(3):145-166.

Strassman, S. 1974. National Human Monitoring Program, EPA. Personal Communication.

U. S. Department of Agriculture. 1969. Monitoring Agricultural Pesticide Residues 1965-1967, A Final Report on Soil, Crops, Water, Sediment, and Wildlife in Six Study Areas. Agricultural Research Service Report 81-32.

U. S. Department of Agriculture. 1973. Meat and Poultry Inspection - 1972. Report of the Secretary of Agriculture to Committee on Agriculture, House of Representatives; Committee on Agriculture and Forestry, U. S. Senate. Washington, D. C.

U. S. Department of the Interior, Bureau of Sport Fisheries and Wildlife. 1964. Waterfowl Tomorrow. Edited by J. B. Linduska. U. S. Government Printing Office, Washington, D. C. 770 pp.

Wiersma, G. B., P. F. Sand and E. L. Cox. 1971. A Sampling Design to Determine Pesticide Residue Levels in Soils of the Conterminous United States. Pesticide Monitoring Journal 5(1):63-66.

Wiersma, G. B., P. F. Sand, and R. L. Schutzman. 1971. National Soils Monitoring Program - Six States, 1967. Pesticide Monitoring Journal 5(2): 223-227.

REFERENCES
(Continued)

Weirsma, G. B., H. Tai, and P. F. Sand. 1972. National Soils Monitoring Program for Pesticides Residue: FY 1969. Environmental Protection Agency. 152 pp.

Wiersma, G. B. 1974. Ambient Pesticide Monitoring in EPA. Ecological Monitoring Branch, Office of Pesticide Programs, Environmental Protection Agency.

Yobs, A. R. 1971. The National Human Monitoring Program for Pesticides. Pesticide Monitoring Journal 5(1):44-46.